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SKYNET APPLICATIONS SOFTWARE PACKAGE (SASP) OPERATOR'S AND USER--ETC(U)
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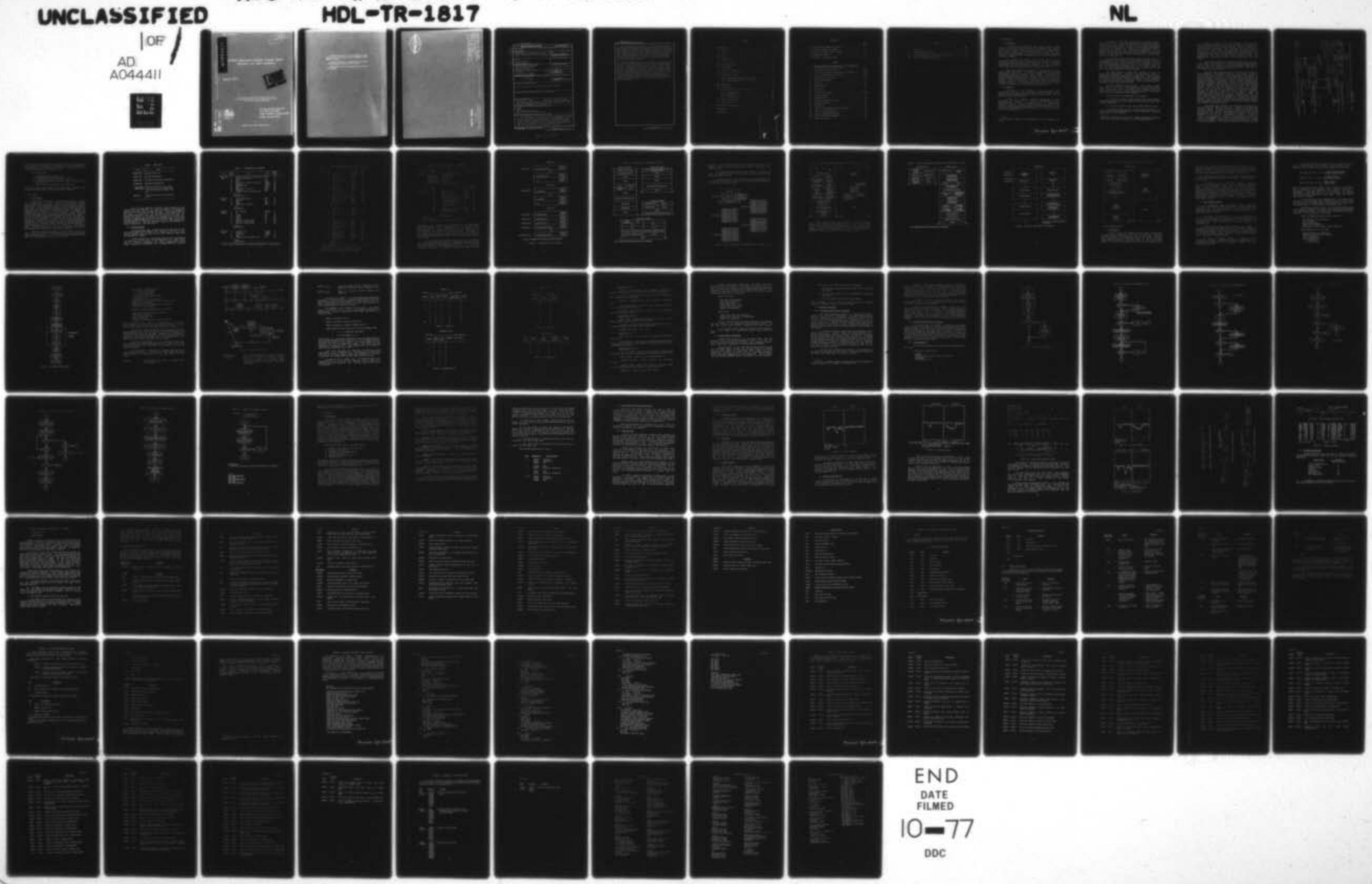

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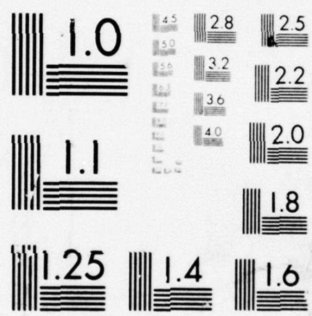

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HDL-TR-1817—*SKYNET Applications Software Package (SASP) Operator's and User's Handbook.*
by Walter J. Scott and John R. Hiller

SKYNET Applications Software Package (SASP) Operator's and User's Handbook

August 1977

This research was sponsored by the Defense Nuclear Agency under subtask R99QAXEB069, Systems Generated EMP, work unit 69, Photon Facility Instrumentation Development.

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The objective of the Defense Nuclear Agency sponsored SKYNET program is to develop a methodology for the assessment of satellite vulnerability to system generated electromagnetic pulse (SGEMP) effects from nuclear weapons. The approach includes a study of basic phenomenology and development of cost-effective simulation techniques, as well as improving SGEMP instrumentation and data acquisition and recording techniques.

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Data acquisition and reduction on a large-scale SGEMP test program are traditionally costly and tedious. The most widely used methods of acquiring and recording the system response waveforms involve the use of oscilloscopes and cameras, the waveforms being captured on Polaroid film. This method requires that the analog waveforms (oscillograms) be digitized, usually by hand, into a computer-compatible format prior to applying automated data analysis techniques. The amount of manual data handling and the need for many skilled technicians make this an error-sensitive and costly procedure.

This report presents a new procedure for capturing and processing complex SGEMP transients. The method is incorporated into an SGEMP Transportable Automated Recording System (STARS). It reduces manual data handling significantly (a major source of errors); outputs data as computer compatible magnetic tapes, annotated hard copies, or both: and lessens the manpower requirements for data acquisition and processing. The software implementation, SKYNET Applications Software Package (SASP), is discussed here to provide STARS operators and users with the detailed information needed to effectively utilize the system. A companion volume, the SKYNET Applications Software Package (SASP) Programmer's Handbook, contains detailed summaries of all SASP source codes.

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1. INTRODUCTION

1.1 Background

The objective of the Defense Nuclear Agency sponsored SKYNET program is to develop a methodology for the assessment of satellite vulnerability to system generated electromagnetic pulse (SGEMP) effects from nuclear weapons. The approach includes a study of basic phenomenology and development of cost-effective simulation techniques, as well as improving SGEMP instrumentation and data acquisition and recording techniques.

Past methods of acquiring and recording SGEMP response waveforms involved the use of oscilloscopes and cameras, the analog oscillograms being digitized by hand. The amount of error introduced through hand digitization is directly relatable to the oscillogram trace width (bloom) and the trace derivative[1] (steepness of slope).

This report presents a new method for capturing and processing complex SGEMP transients. The method is incorporated into an SGEMP Transportable Automated Recording System (STARS). It reduces manual data handling significantly (a major source of errors); outputs data as computer-compatible magnetic tapes, annotated hard copies, or both; and lessens the manpower requirements for data acquisition and processing personnel. Thus, the STARS enhances SGEMP data accuracy and reliability through elimination of hand digitization and through better signal recording resolution, while reducing test operational costs.

1.2 Overview

The content of this handbook is directed toward STARS operators and data users, the text being chiefly concerned with the description of the SKYNET Applications Software Package (SASP). A brief synopsis of each section follows.

Section 2 is a complete, detailed presentation of system calibration and data files. A thorough understanding of file structures--their content and usage--is basic to understanding subsequent sections. Through familiarization with the various file entries, the user can gain an appreciation for what information he must provide the system before testing can take place, as well as for the structure of the data bank.

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[1]*Data Reduction Planning and Coordination, EG&G, Albuquerque, NM (1972).*

In section 3, user input requirements are described in detail. Sections 3.2 and 3.3 provide the operator with the knowledge needed to run the STARS console terminal and generate or modify the system files. The main operation and control program, indirect command file TESTSEQ, is presented in section 3.4.1. Modular in construction, SASP is composed of well-defined tasks that function independently of one another; however, the order in which they are executed is important. Section 3.4.2 discusses some of the do's and don'ts for running single tasks in the manual mode.

The raw data acquired from the transient digitizer is not in a form compatible for processing by digital computer. Usually, there is an overabundance of data describing the waveform. Sometimes, there is a lack of data describing certain portions of the waveform. It is the task of the normalization procedure (sect. 4.1) to process these raw data, with their excesses and deficiencies, and to obtain from the raw data a more usable presentation of the waveform.

The STARS operator is tasked with reviewing the data for quality and completeness. He performs data evaluation (sect. 4.2) independent of the data's context to the experiment. Rather, data are examined to identify hardware relatable problems, e.g., data exceeding the digitizer writing rate. Section 4.3 presents a typical production run including user output plots and tables. Section 4 concludes with a discussion of data storage and retrieval.

Section 5 summarizes each SASP module: the indirect command file, tasks, and subroutines. These summaries, when used with the flowcharts (sect. 3.4.1) and the discussion that follows, provide an overview of the data taking. A more detailed explication of the modules may be found in the SASP Programmer's Handbook.*

The SASP software was developed for two reasons:

a. To control the Harry Diamond Laboratories optical systems, the calorimeter data acquisition channels, and the Tektronix (TEK) R7912 transient digitizers.

b. To record, process, store, and reproduce SGEMP test data.

To appreciate many of the software tasks and to obtain an overview of the entire STARS operation, a brief presentation of the data-taking sequence is now developed.

**Walter J. Scott and John R. Hiller, SKYNET Applications Software Package (SASP) Programmer's Handbook, Harry Diamond Laboratories.*

Figure 1 is a STARS system block diagram. Prior to any data taking, the STARS operator must generate the system files by typing in the user-supplied data for the probes, sensors, devices, cables, etc., to be used on the experiment. This information is input at the main graphic display console TEK 4010 cathode ray tube terminal and stored on disk unit No. 0 (DK0), a Digital Equipment Corp. (DEC) RK11 disk. This is designated the "system" disk and contains the system calibration and configuration files, SASP, and DEC RSX-11M operating system. The remaining disk, disk unit No. 1 (DK1), is used exclusively for data storage.

Once the data channels are completely defined, they are "known" to the system. Any calculations on the data requiring probe sensitivity factors, time base settings, or any other parameter can be made by retrieving the entry from the appropriate system file. The process of data acquisition can now proceed.

The first step in acquiring data is to adjust the knob settings on the digitizers. The TEK R632 television (TV) monitors present a visual display to aid the operator in the adjustment of the vertical and horizontal baseline positions, as well as the intensity settings. The operator can adjust them by running the program task KNOB and making the required adjustments. An operations control program, TESTSEQ, itself composed of individual tasks, allows interactive control of the entire data-taking sequence. Then task BASE is run to acquire background data from each digitizer. These data are stored on DK1 in the file named MAIN.DAT. Task BASE may be repeated if errors have been flagged. (Error flags are discussed in appendix A.) Otherwise, the operator continues by acquiring calibration signals from the calibration generators located inside the optical transmitters. Task CAL accomplishes the entire calibration sequence, including automatic turn on of the optical equipment and triggering of the digitizers. Task CAL data are then plotted on the terminal for evaluation by the STARS operator. Again, the flexible TESTSEQ permits looping back to reacquire these calibration waveforms if desired. The next task, PREDAT, prepares the system for the actual data shot.

Task PREDAT sends commands to all digitizers and places them in the proper mode for transient recording. (Appendix B discusses these commands in detail.) The acquisition and storage of raw digitizer data and the acquisition, reduction, and storage of calorimeter data are then performed by task DATAPC. Task DATAPC also turns on the optical transmitters and sets their programmable attenuators. As shown in figure 1, the τ_0 interrupt trigger is generated by an x-ray detector source and transmitted over a dedicated optical trigger link. It does so after task DATA has reached the wait mode signified by the message "WAITING FOR TRIGGER." The trigger, initiated by the simulator firing,

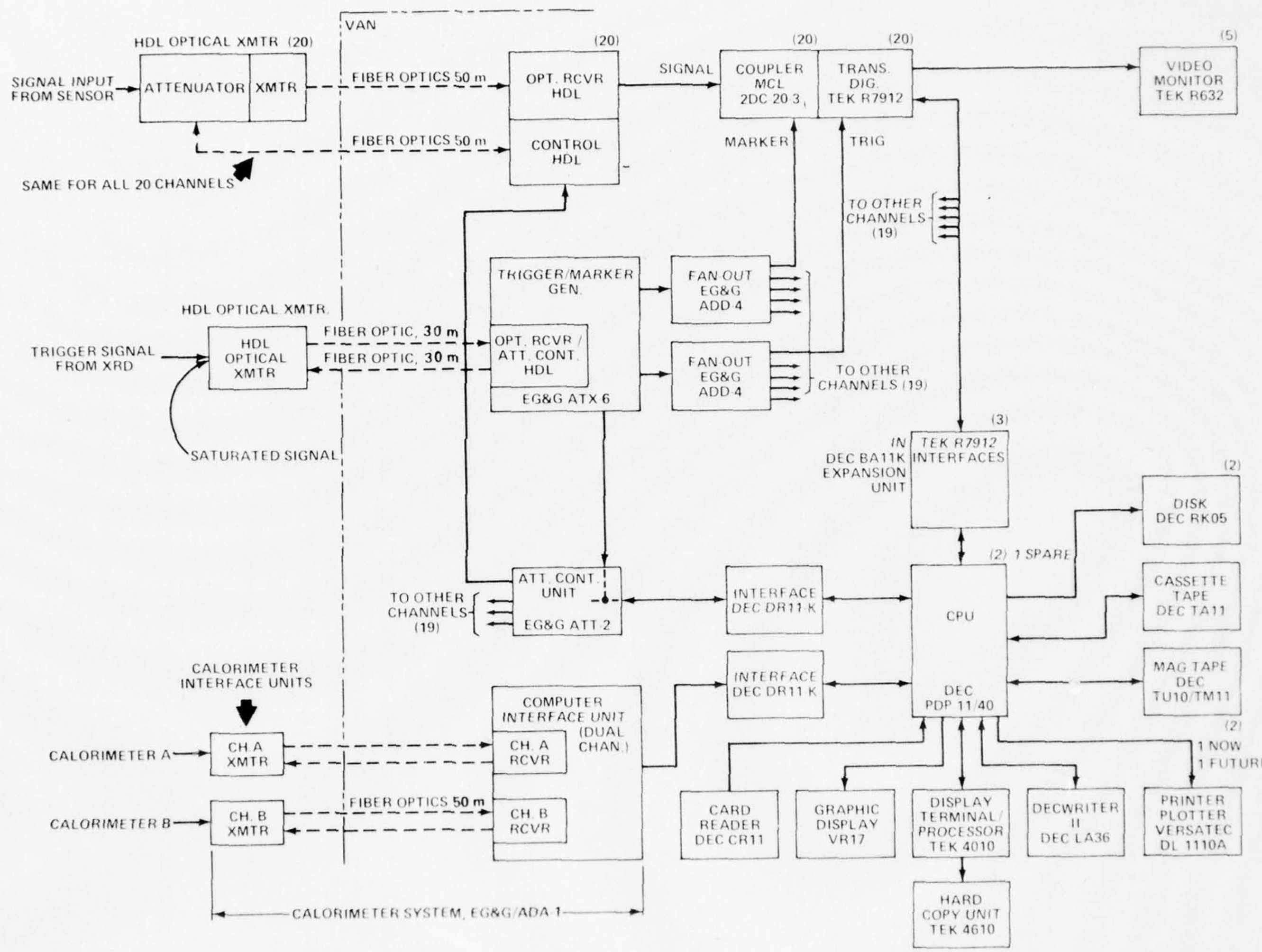


Figure 1. System generated electromagnetic pulse Transportable Automated Recording System (STARS).

is used to begin calorimeter data acquisition and to start the sweep for each digitizer. Sensor data are transmitted through the optical data links, where they are recorded by the digitizer's internal memory for a brief period before being transferred to DK1.

Five steps remain:

a. To normalize the data (sect. 4.1)
b. To scale the data (task SCALE, sect. 3.2)
c. To parametize the data (task MARK, sect. 4.2.4)
d. To provide graphical and tabular output for the data user (sect. 4.3)
e. To store the data on magnetic tape (sect. 4.4)

Section 5 includes a brief summary of all SASP tasks. Detailed task descriptions may be found in the SASP Programmer's Handbook.

2. DATA FILES

2.1 Introduction

System files are divided into three classifications: calibration, configuration, and data. Calibration files contain pertinent specifications on the measurement channel hardware--sensors, probes, optical data links, attenuators, baluns, etc. The system configuration file stores all the information needed to uniquely define the physical variables of the experiment at a given moment in time. In general, the SYSCON.DAT file is unique for any shot; however, if no variables are changed between shots and the simulator parameters remain unchanged, only the shot number entry in the SYSCON.DAT file header will change. A copy of the current SYSCON.DAT file becomes an entry in each shot file. The shot file, Snnnnxx.DAT, in addition to the system configuration, contains all the data for a given shot. The data include the baseline, calibration, raw, and scaled data waveforms for each digitizer in the system, as well as computed parameters and user or operator comments. A complete description of all the files is presented in the following pages. A knowledge of these file structures is basic to understanding the operation of the software and usage of the data base.

The list that follows (table I) defines the data files used by SASP. All but the shot files and MAIN.DAT file are to be on DK0; the remaining are placed on DK1. (All are in user file directories (UFD's) with a user identification code (UIC) of [100,100].)

TABLE I. DATA FILES

File	Data
PRBCAL.DAT	Probe calibration
ATNCAL.DAT	Device calibration
XCHCAL.DAT	Transmission channel calibration
SYSCON.DAT	System configuration
Snnnnxx.DAT (SHOT.DAT)	Taken for simulator shot named with four-digit shot number nnnn and two-character simulator code xx
MAIN.DAT	Preliminary name for Snnnnxx.DAT file

Once the shot number and simulator code locations in the SYSCON.DAT file have been set (by using task SHOTNO), file SYSCON.DAT points to the name of the current shot file. This name is composed of the letter "S" followed by the four-digit shot number and the two-character simulator code with the usual extension of ".DAT". For example, for shot No. 115 on simulator P1, the shot file is S0115P1.DAT. This name is established for the file by task TABIN, which in one of its functions renames the MAIN.DAT file to the shot file name pointed to by the SYSCON.DAT file. (The term "SHOT.DAT" is used in this handbook as a general reference to a shot data file.)

2.2 File Structures

In the following pages, the structure of the data files is laid out in both graphical and tabular form (tables I to IV, fig. 2 to 4). Wherever possible, space has been left for future expansion; these areas are designated as "spare."

Certain entries in the calibration files are for record keeping only and are not used by SASP. For the PRBCAL.DAT file, these entries are the following: measurement type, model, manufacturer's serial number, connector, and parameter; for the ATNCAL.DAT file: model and

TABLE II. CALIBRATION FILE ENTRIES

File	Size (bytes)	Item	Type[1]	Offset (bytes)
PRBCAL.DAT entry	4	Probe identification (four characters)	ASCII	0
	4	Transfer function (dB)	FP	4
	4	Delay	FP	8
	8	Units	ASCII	12
	2	Flag (such as integration required)	Integer	20
	2	Balun No.	Integer	22
	2	Measurement type	ASCII	24
	8	Model	ASCII	28
	8	Manufacturer's serial No.	ASCII	30
	8	Connector	ASCII	44
	4	Parameter (such as equivalent area)	FP	52
	54	Total		
	64	Provided for		
ATNCAL.DAT entry	4	Device identification	ASCII	0
	4	Gain (dB)	FP	4
	4	Delay	FP	8
	8	Model	ASCII	12
	8	Manufacturer's serial No.	ASCII	20
	28	Total		
	32	Provided for		
XCHCAL.DAT header	2	No. of channels	Integer	0
	4	Δt_1	FP	4
	4	Δt_{trig1}	FP	8
	4	Δt_{trig2}	FP	12
	4	Δt_{fidu}	FP	16
	4	Δt_{vert}	FP	20
	4	Balun No. 1 insertion gain	FP	24
	4	Balun No. 2 insertion gain	FP	28
	4	Balun No. 3 insertion gain	FP	32
	34	Total		
	48	Provided for		
XCHCAL.DAT entry	2	Transmitter No.	Integer	0
	2	Fiber No.	Integer	2
	2	Receiver No.	Integer	4
	4	Delay	FP	8
	4	Calibration pulse reference level	FP	12
	14	Total		
	16	Provided for		

[1] *ASCII: American Standard Code for Information Interchange; FP: Floating point.*

TABLE III. SYSTEM CONFIGURATION (SYSCON.DAT) FILE ENTRIES

Entry	Size (bytes)	Item	Type[1]	Offset (bytes)
Header	6	Date	Three integers	0
	6	Time	Three integers	6
	4	Shot No. in ASCII	ASCII	12
	2	Shot No.	Integer	16
	2	No. of TEK R7912's	Integer	18
	2	No. of TEK R7912 controller boards	Integer	20
	2	No. of channels	Integer	22
	2	Virtual block No. (VBN), baseline	Integer	24
	2	VBN, calibration	Integer	26
	2	VBN, raw	Integer	28
	2	VBN, scaled	Integer	30
	2	VBN, parameters	Integer	32
	2	VBN, user comments	Integer	34
	2	Simulator identification	ASCII	36
	2	Wire type/configuration code	ASCII	38
	4	Charging voltage/output level	FP	40
	4	Tank vacuum	FP	44
	4	Voltage diode peak value	FP	48
	4	Current diode peak value	FP	52
	30	Comment	ASCII	56
	2	No. of blocks in SHOT.DAT	Integer	86
	4	CALOR result No. 1 (peak value)	FP	88
	4	CALOR result No. 2 (peak value)	FP	92
	2	No. of samples No. 1	Integer	96
	2	No. of samples No. 2	Integer	98
	2	CALOR error flag	Integer	100
	102	Total		
	128	Provided for		
TEK R7912	2	TEK R7912 device address	Integer	0
	2	Channel No.	Integer	2
	2	Error flag	Integer	4
	2	Sweep rate	Integer	6
	2	Vertical sensor	Integer	8
	2	Bloom	Integer	10
	2	Baseline position (two parts)	Integer	12
	14	Total		
	16	Provided for		
Channel	2	Error flag	Integer	0
	6	Test point name	RAD50	2
	4	Attenuation identification	ASCII	8
	4	Probe/sensor identification	ASCII	12
	2	XRD bias	Integer	16
	4	Pretransmitter cable delay	FP	20
	4	Device identification	ASCII	24
	2	Transmitter No.	Integer	28
	2	Transmitter attenuation setting	Integer	30
	4	Postreceiver cable delay	FP	32
	4	Postreceiver gain value	FP	36
	2	No. of TEK R7912's	Integer	40
	2	TEK R7912 No. 1 number	Integer	42
	2	TEK R7912 No. 2 number	Integer	44
	2	TEK R7912 No. 3 number	Integer	46
	4	Data link gain	FP	48
	4	Scale factor	FP	52
	4	Overall delay (Δt_{data})	FP	56
	58	Total		
	64	Provided for		

[1] *ASCII: American Standard Code for Information Interchange.*
FP: Floating point.
RAD50: Special algorithm used by DEC software to increase the packing density of ASCII characters in storage. For example, the nine-character ASCII TEST POINT NAME in the CHANNEL shown above is represented in six bytes, whereas normal ASCII representation would require nine bytes.

TABLE IV. MAIN DATA (SHOT.DAT) FILE ENTRIES

Entry	Size (blocks)	Item		
Components	5	Copy of finalized SYSCON		
	2 per TEK R7912	Baseline data		
	2 per TEK R7912	Calibration data		
	8 per TEK R7912	Raw data		
	4 per TEK R7912	Scaled data		
	1/4 per TEK R7912	Parameters		
	1/8 per TEK R7912	User comments (64 characters) last block filled		
	Size (bytes)		**Type[1]**	**Offset (bytes)**
Parameters	2	Evaluation flag	Integer	0
	2	Fiducial time	Integer	2
	2	Start of data time	Integer	4
	2	Time of peak of interest	Integer	6
	2	End of data time	Integer	8
	2	Time of peak of calibration	Integer	10
	4	Time to start of data from simulator pulse fire	FP	12
	4	Peak of interest	FP	16
	4	Time to peak of interest from data start	FP	20
	4	Area	FP	24
	24	Comment on calibration data	ASCII	28
	24	Comment on raw data	ASCII	52
	24	Comment on scaled data	ASCII	76
	100	Total		
	128	Provided for		

[1]*FP: Floating point;*
ASCII: American Standard Code for Information Interchange

manufacturer's serial number; and for the XCHCAL.DAT file: fiber number and receiver number. If delay calculations are not required, delay entries can be zero in the calibration files, as well as in the SYSCON.DAT file. The postreceiver gain value in each channel entry in the SYSCON.DAT file also is for record keeping. The manner of calculating the data link gain includes the data link gain in the system gain calculation automatically without needing an additional reference to this item.

The transmitters and channel numbers used in the SYSCON.DAT file are defined in the XCHCAL.DAT file. Though the SYSCON.DAT file may have fewer channels defined than does the XCHCAL.DAT file (never more), its first is the first in the XCHCAL.DAT file and so on. To change transmitter addresses, the XCHCAL.DAT file must be changed (by using

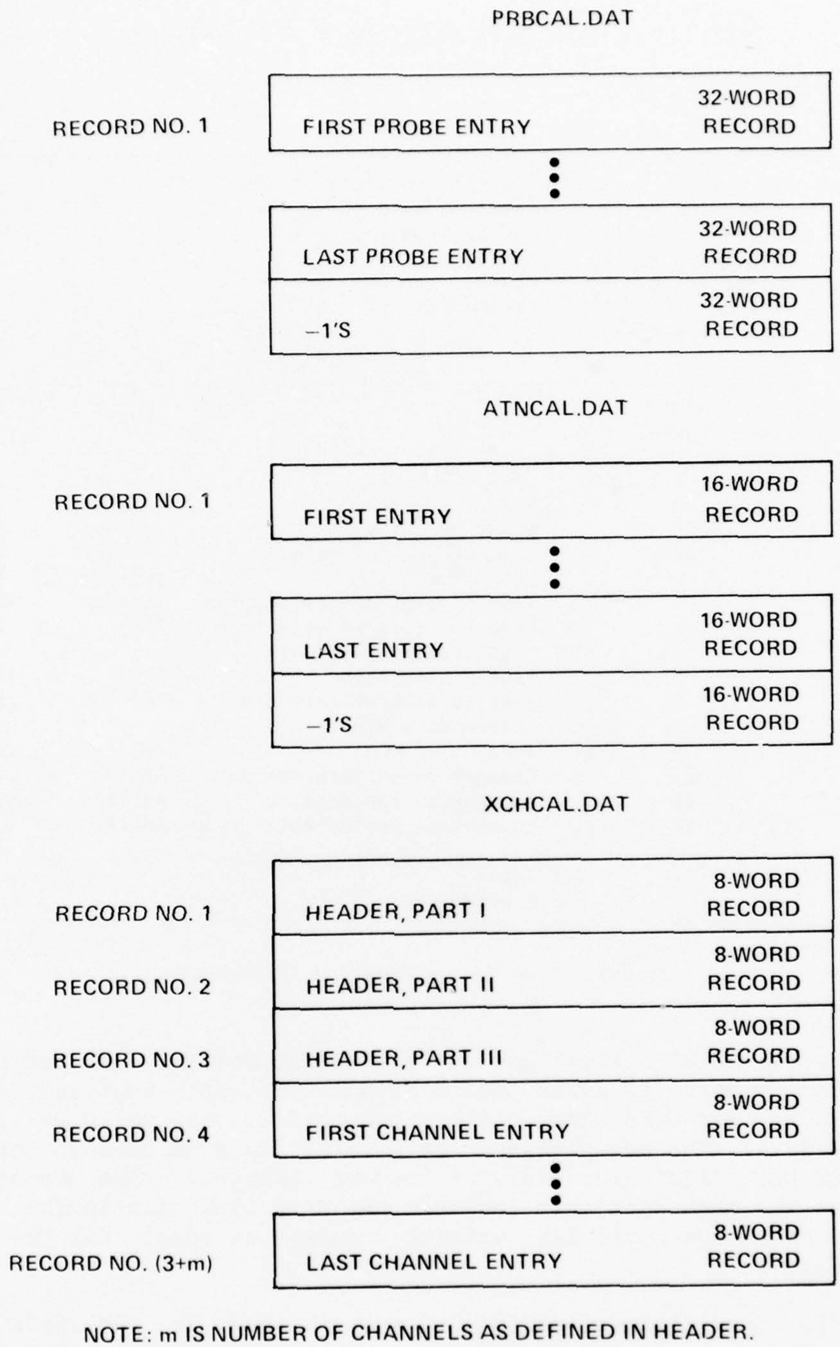
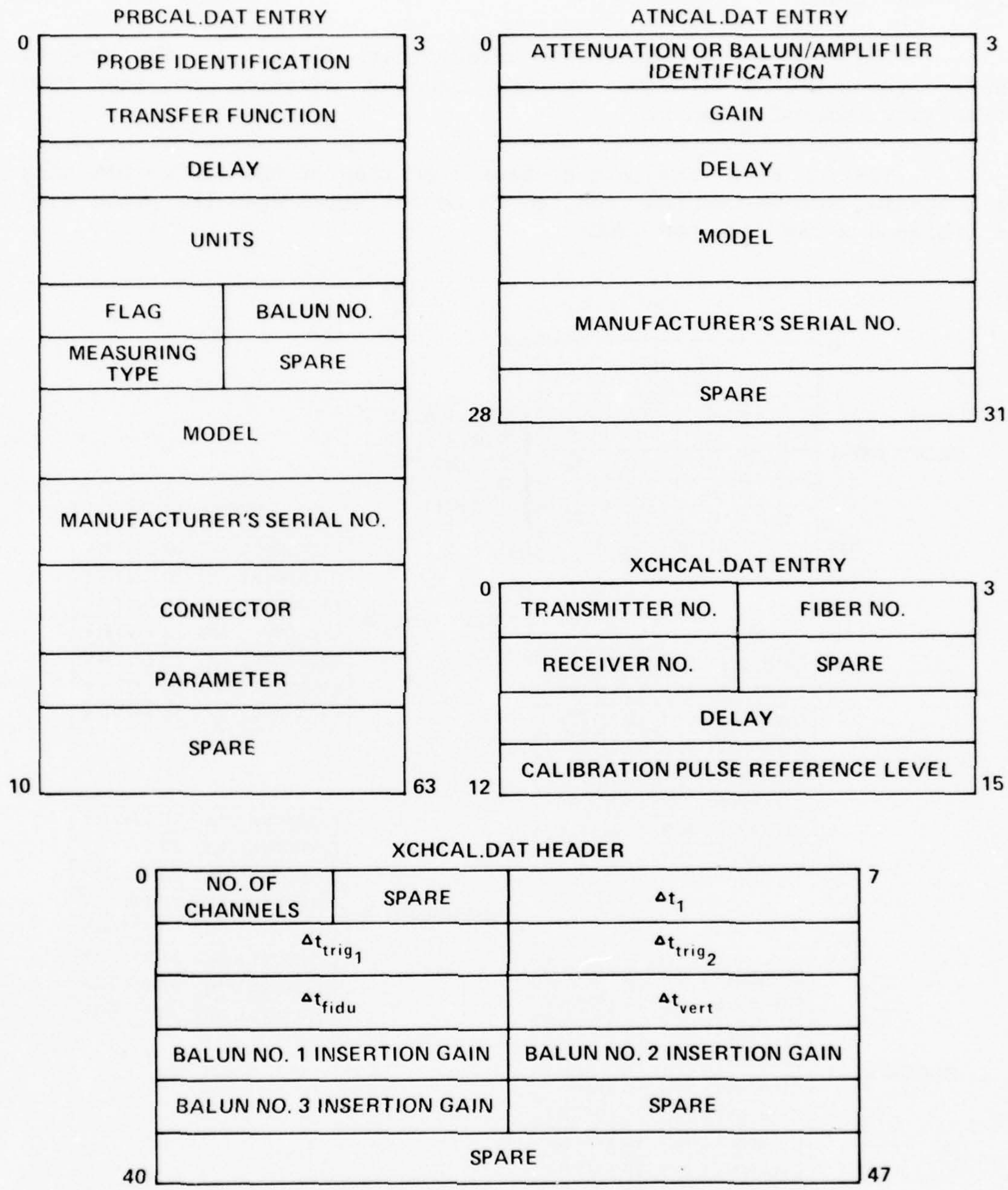


Figure 2. Calibration file structures.

Figure 2. Calibration file structures (Cont'd).



NOTE: NUMBERS OUTSIDE OF BOXES ARE BYTE NUMBERS.

task XCH), and the SYSCON.DAT file must be regenerated (by using task CONGEN). Changing digitizer addresses also requires regenerating the SYSCON.DAT file.

The transmitter number and transmitter address are the same to SASP. The value is selected by the cabling position on the EG&G attenuator controller unit.

The XRD bias item in the channel entries of the SYSCON.DAT file is a special record-keeping feature to be activated when the probe used is a biased x-ray detector (XRD).

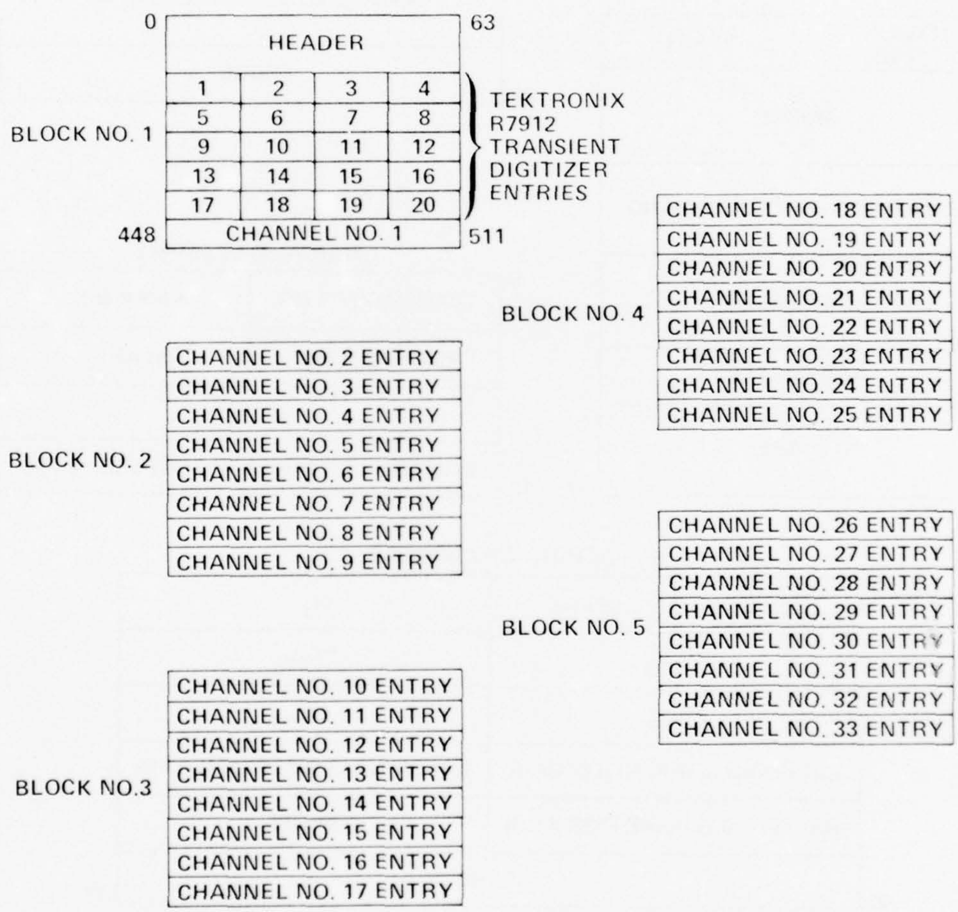
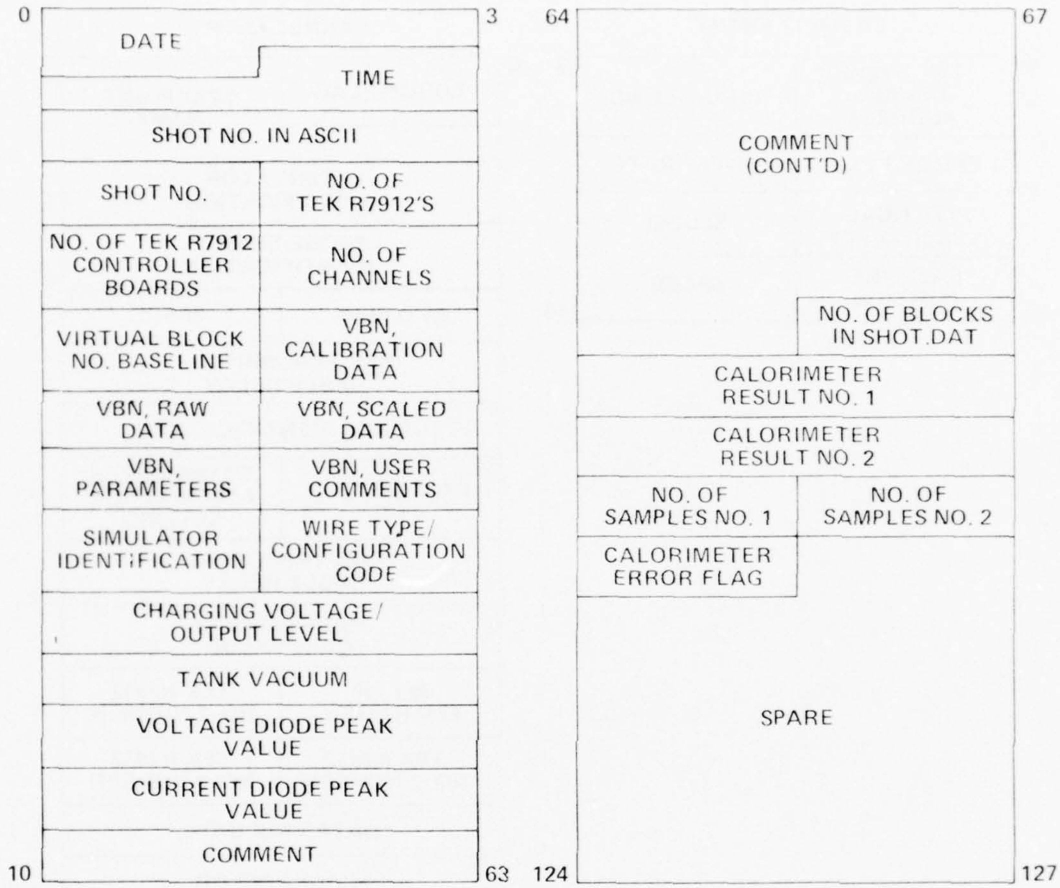


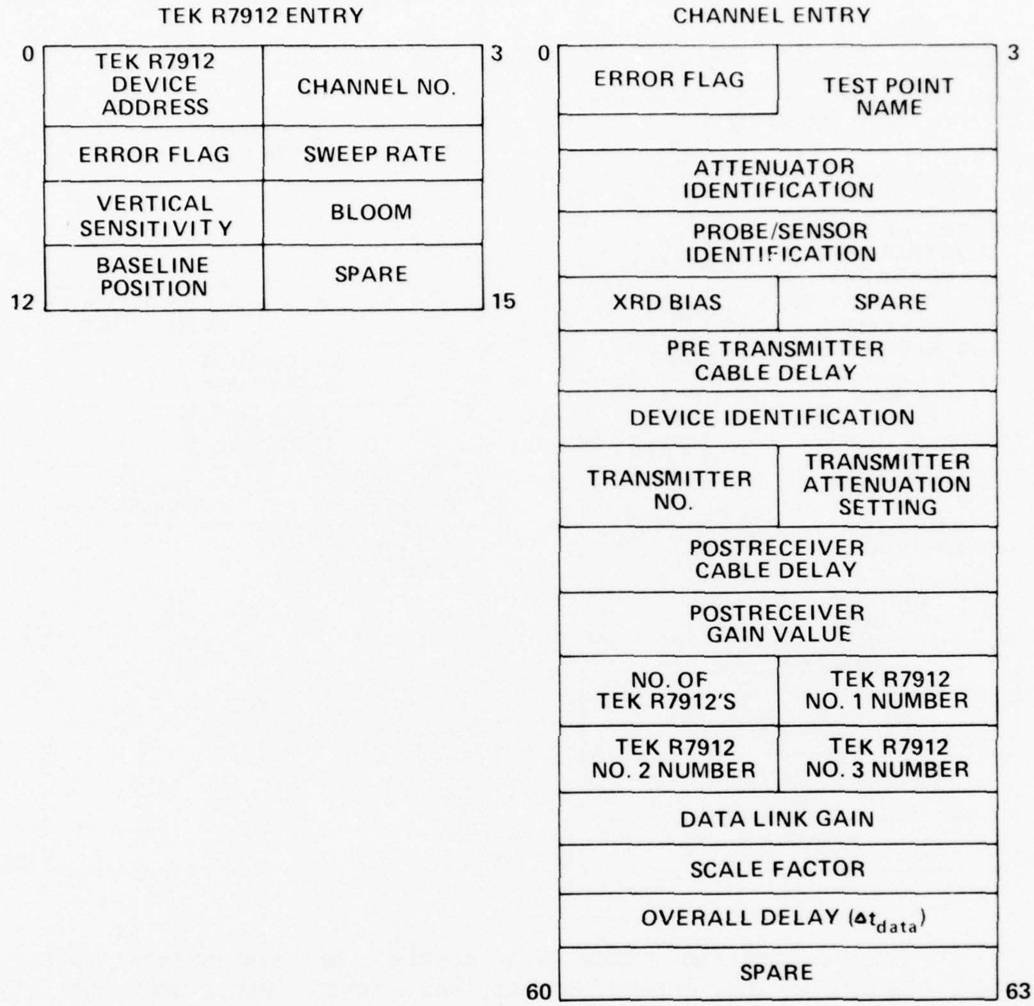
Figure 3. System configuration (SYSCON.DAT) file structure.

Figure 3. System configuration (SYSCON.DAT) file structure (Cont'd).



The calibration files are handled by subroutines PRBREF, PRBSCH, ATNREF, ATNSCH, XCHREF, XCHDRI, and XCHSCH. The SYSCON.DAT file can be read and rewritten by the subroutine SCIO (SCIN, SCOUT as entry points). The MAIN.DAT and SHOT.DAT files may be accessed through the subroutine DATFIO. The calibration files are record oriented, while the SYSCON.DAT, MAIN.DAT, and SHOT.DAT files are block oriented.

Figure 3. System configuration (SYSCON.DAT) file structure (Cont'd).



NOTE: NUMBERS OUTSIDE OF BOXES ARE BYTE NUMBERS.

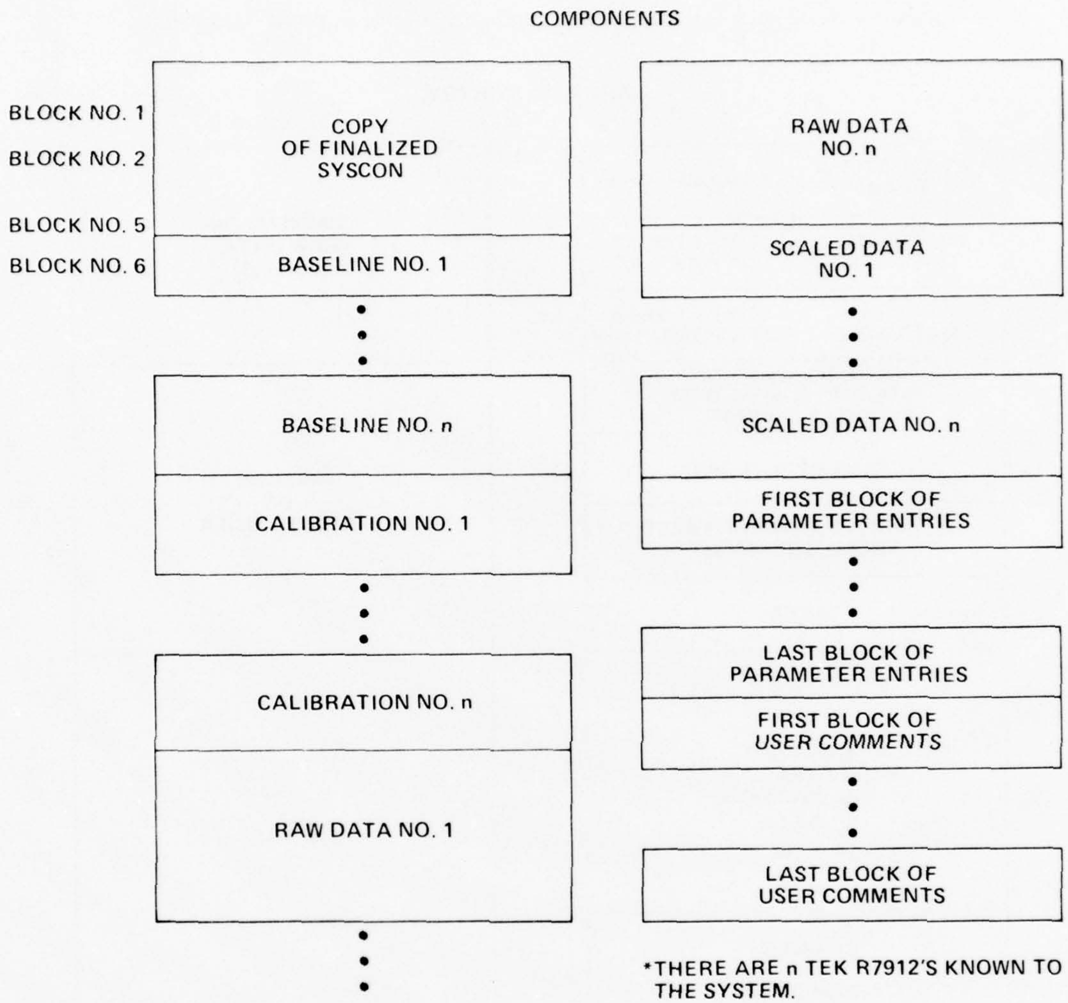
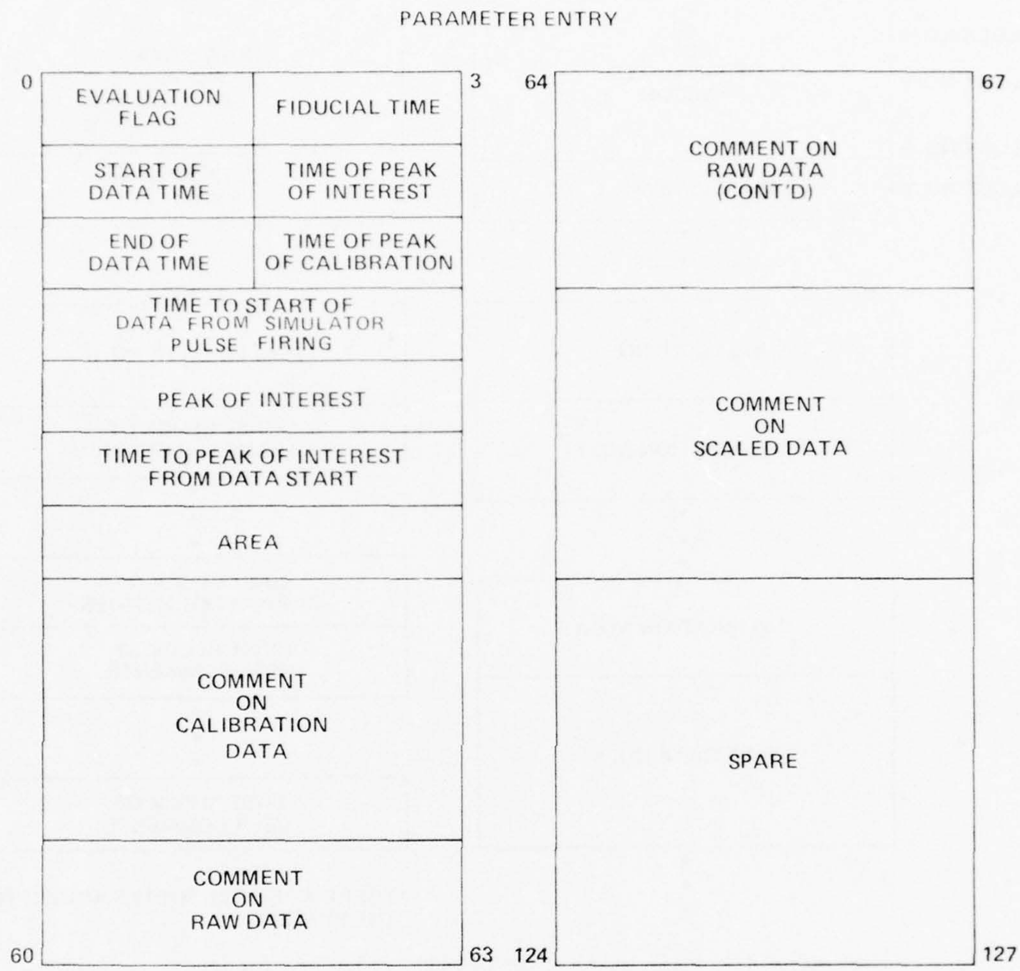


Figure 4. Main data (SHOT.DAT) file structure.

Figure 4. Main data (SHOT.DAT) file structure (Cont'd).



3. DATA SYSTEM OPERATIONS

3.1 Introduction

Prior to testing, many unknown quantities remain to be defined. The data system calibration files must be generated; information concerning physical test variables must be stored in memory. Amplifier gains, calibration pulse reference levels, and sensor and probe identification numbers must be made known to the data system. Section 3.2 defines the procedures for constructing calibration files,

the files that contain the information necessary to conduct a test. Separate tasks (programs) exist for modifying each of these calibration files. Log forms to be filled out by the STARS operator and the experimeter also are described. The information on these logs provides the needed cross references between calibration and data files.

Next, terminal input conventions are presented. This information is of use to the STARS console operator for the input of tabular data from the log forms.

A description of the data-taking sequence follows in section 3.4. The SASP software can be run in the manual or automatic mode. That is, the separate, modular tasks can be combined into an indirect command file and run automatically. The SASP software was specifically designed to run in this mode, under the control of TESTSEQ. Section 3.4.1 explains the features of TESTSEQ and the procedures for abnormally aborting TESTSEQ. Precautions to be observed for running the SASP tasks in the manual mode also are given. Discussion on disk-to-tape transfer conventions and the method for preparing new disks conclude this section.

3.2 Data System Generation

The calibration and configuration files, XCHCAL.DAT, ATNCAL.DAT, PRBCAL.DAT, and SYSCON.DAT, must be established before data taking can occur. Devices and attenuators to be used should be entered in the ATNCAL.DAT file by using task ATN. Probes are specified in the PRBCAL.DAT file with task PRB.

The contents of the XCHCAL.DAT file must be established before generating the SYSCON.DAT file; otherwise, the transmitter addresses are not available when needed. Task XCH provides for the generation of the XCHCAL.DAT file. Then task CONGEN may be used to establish the SYSCON.DAT file.

Before beginning data system generation, the alignment of transmitters, channels, and digitizers should be decided. Creating the XCHCAL.DAT file provides the association between the channel number and the transmitter address. After the SYSCON.DAT file is created, task LOG is run, and the selected channel numbers are input into the digitizer log. These actions complete the link.

To change a digitizer address, the SYSCON.DAT file is regenerated. To modify a transmitter address, the XCHCAL.DAT file is modified, and the SYSCON.DAT file is regenerated. The SASP data input requirements are below.

The generalized SASP data channel can be visualized as shown in figure 5. Each item has a gain or delay or both associated with it. Gains are given in decibels calculated from equations of this form:

$$\text{Attenuator gain (dB)} = 20 \log_{10} \frac{\text{output (selected units)}}{\text{input (selected units)}} ,$$

$$\text{Probe gain (dB)} = 20 \log_{10} \frac{\text{output (volts)}}{\text{input (selected units)}} ,$$

$$\text{Device gain (dB)} = 20 \log_{10} \frac{\text{output (volts)}}{\text{input (volts)}} .$$

The gain of the transmission channel ("data link gain") is calculated from a knowledge of the calibration pulse reference level and a measurement of the peak recorded at the digitizer. The gain is calculated in task CHKCAL (sect. 4.2.2). All the gains are combined into a single overall scale factor by task SCALE. There, the overall delay also is calculated.

The TEK R7912's have many characteristics. They receive their own entry in the configuration file (SYSCON.DAT) which is linked to the channel entry by the channel number. Three digitizers may be so linked to a single channel. (See the SASP file structures, sect. 2.2.)

The attenuator, probe, device, and transmission channel also receive special treatment. Calibration files are established to define their characteristic gains and delays and to perform other bookkeeping functions. The input required is as follows:

DEVICE OR ATTENUATOR (ATNCAL.DAT file, task ATN)

Identification (four characters)
Gain (decibels)
Delay (nanoseconds)
Model (eight characters)
Manufacturer's serial number (eight characters)

PROBE (PRBCAL.DAT file, task PRB)

Identification (four characters)
Transfer function (gain in decibels)
Delay (nanoseconds)
Data processing flag
1 = integration
0 = simple scaling

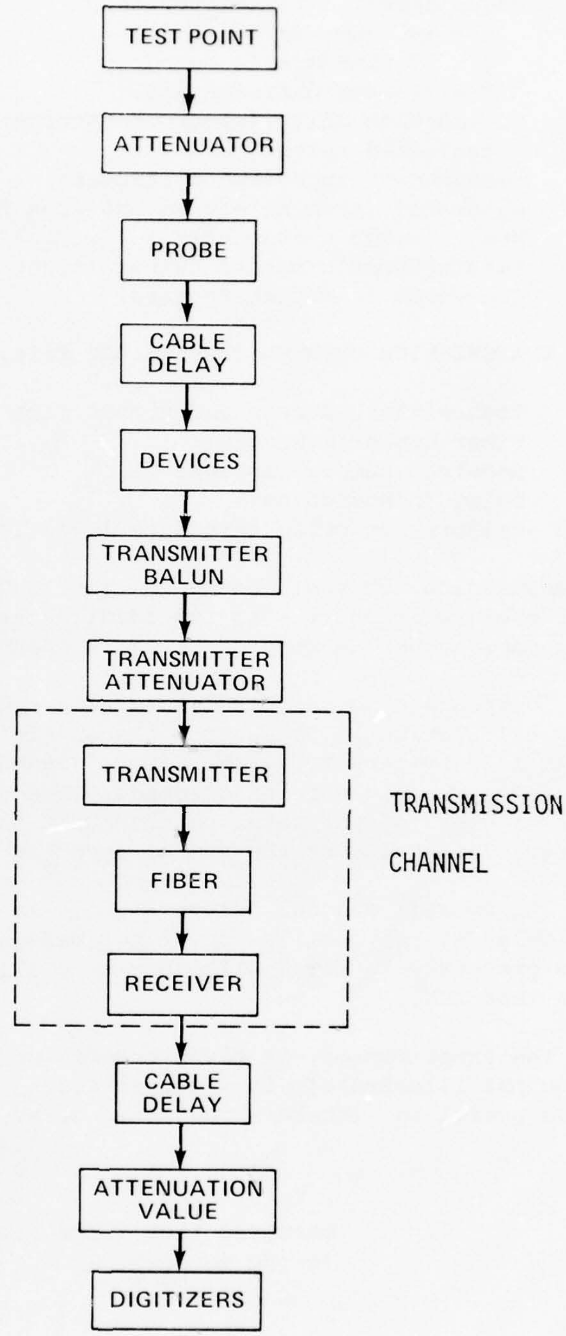


Figure 5. Generalized data channel.

Balun number (transmitter input)
1 = 100 ohms differential
2 = 50 ohms single ended
3 = 78 ohms differential
Scaled data units (eight characters)
(selected units)
Measurement type (two characters)
Parameter (such as equivalent area for B-dot probe)
Model (eight characters)
Manufacturer's serial number (eight characters)
Connector (eight characters)

TRANSMISSION CHANNEL (XCHCAL.DAT file, task XCH)

Transmitter address and number (integer)
Fiber number (integer)
Receiver number (integer)
Delay (nanoseconds)
Calibration pulse reference level (millivolts)

Each transmission channel entry in the XCHCAL.DAT file is assigned a channel number, which serves as its identification and which is forced to be the same number as that of the data channel that includes it.

There are also certain system-wide constants required for gain and delay calculations. These are placed in the header section of the XCHCAL.DAT file by task XCH. The delay constants are illustrated in figure 6 and are given in nanoseconds. The gain values are the insertion loss of each of the three baluns built into the transmitters. The negative absolute value of the number input is stored.

The overall channel delay, Δt_{data}, is calculated in task SCALE. The time delay of the oscilloscope time base, Δt_{ε}, drops out of any equations presently in use. All other Δt's illustrated in figure 6 are input for task XCH.

The experimenter is given several pertinent delay times on the tabular output illustrated in section 4.3. The following definitions will prove useful in interpreting the delay time factors in these tables.

DT1(Δt_1) measured time from source to trigger sensor (x-ray sensor),

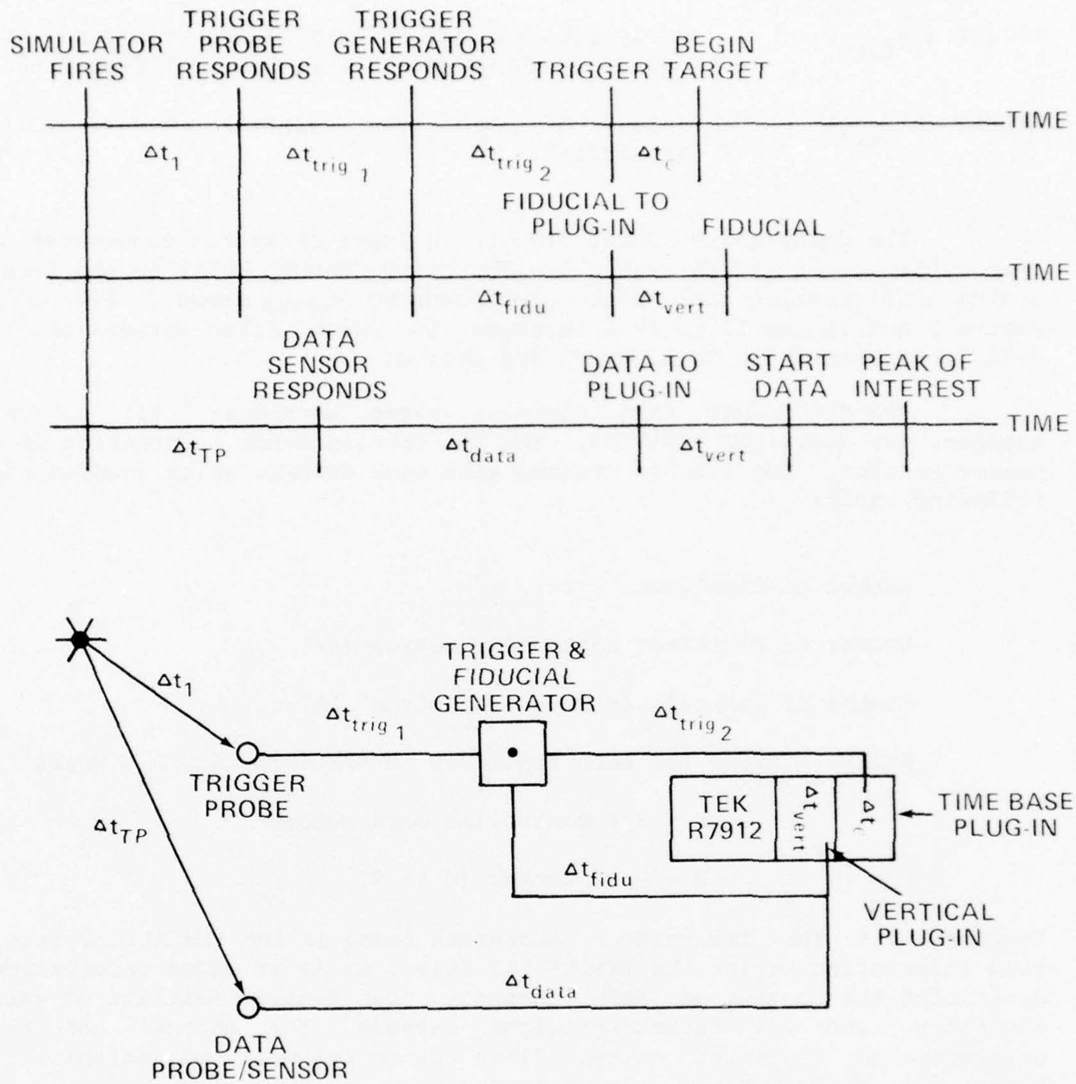


Figure 6. Delay considerations.

DTRIG2(Δt_{trig1} + Δt_{trig2}) trigger sensor delay from trigger sensor to fiber optic transmitter, fiber optic trigger link delay, delay time through trigger generator, and delay in all cables from output of trigger generator to external trigger input on TEK R7912,

DTFIDU (Δt_{fidu}) — delay time through fiducial generator and all cables up to TEK R7912 vertical amplifier input,

DTVERT (Δt_{vert}) — delay of digitizer vertical channel (7A19 amplifier).

The delay entry DELAY in the quick-look system configuration dump table is Δt_{data} in figure 6. The entry CHANNEL DELAY in the final system configuration table also corresponds to Δt_{data} shown in figure 6. Figure 2 and tables II to IV illustrate in which files several of the delay constants shown in figure 6 are stored.

The SYSCON.DAT file contains three sections: (1) channel entries, (2) digitizer entries, and (3) certain other information in a header section. The file is created with task CONGEN, which expects the following input:

Number of digitizers ($\leq$20)

Number of digitizer controller boards ($\leq$4)

Number of channels ($\leq$ number in XCHCAL.DAT file)

Unibus address for each digitizer in the form $16X0D0_8$, where

X = 3 + controller card number

D = unit number (0 to 7)

Combined with the transmitter addresses found in the XCHCAL.DAT file, this information begins the SYSCON.DAT file. To it is added information describing the content of each channel, the desired settings of each digitizer, and the interconnections between the channel and the corresponding digitizer entry. (This connection must be established before the new SYSCON.DAT file is used.)

Four input log forms are necessary to fulfill the entry requirements of the SYSCON.DAT file. The information is entered with task LOG, which has four "pages" of input that correspond to the format of the logs. The standard SASP terminal input conventions apply.

Figures 7 to 10 are sample logs. The comments column on the transmitter log (fig. 8) is for user comments to be entered at a different time into a different file. The exact nature of the entries is as follows:

PROBE LOG

SHOT NO.________________________(next expected)

CHANNEL	TEST PT	ATTN ID	SENSOR ID	PRE XMTR CABLE DELAY	DEVICE ID
1					
2					
3					
.					
.					
.					
20					

Figure 7. Probe log.

TRANSMITTER LOG

SHOT NO.________________________(next expected)

CHANNEL	XMTR ATTN	XRD BIAS	COMMENTS (LAST SHOT)
1			
2			
3			
.			
.			
.			
20			

Figure 8. Transmitter log.

RECEIVER LOG

DATE__________

START SHOT______ END SHOT_____

CHANNEL	DELAY (REC-DIG)	ATTN (REC-DIG)
1		
2		
3		
.		
.		
.		
20		

Figure 9. Receiver log.

DIGITIZER LOG

DIG. NO. (OPER)	SWEEP (NS/DIV)	VERT SENS (mV/DIV)	BASELINE OFFSET (± MINOR DIV)	CHANNEL NO.

Figure 10. Digitizer log.

Probe log (fig. 7)

TEST PT: test point name, nine alphanumeric characters for specifying probe location, test conditions, and other characteristics

ATTN ID: identification of attenuator entered in ATNCAL.DAT file ("blank" means no attenuator)

SENSOR ID: identification of probe entered in PRBCAL.DAT file

PRE XMTR CABLE DELAY: value to reflect delays not accounted for by other pretransmitter entries

DEVICE ID: identification of device entered in ATNCAL.DAT file ("blank" means no device)

Transmitter log (fig. 8)

XMTR ATTN: transmitter attenuation, 0 to 45 dB in 3-dB steps (negative absolute value of input is stored)

XRD BIAS: special case, integer parameter to be used in specifying variable probes, particularly biased XRD's

COMMENTS (LAST SHOT): user comments

Receiver log (fig. 9)

DELAY (REC-DIG): value reflects delay between the receiver and digitizer

ATTN (REC-DIG): value records attenuation between receiver and digitizer (not used in calculations, since measuring data link gain automatically includes it)

Digitizer log (fig. 10)

DIG. NO. (OPER): operator picks alignment of channels and digitizers; task LOG prints digitizer number and requests channel number

SWEEP (NS/DIV): sweep rate in nanoseconds/division

VERT SENS (mV/DIV): vertical sensitivity in millivolts/ division

BASELINE OFFSET (±MINOR DIVS): baseline position offset given in minor divisions about center of target, range of 20

CHANNEL NO.: (same as for "DIG. NO. (OPER)")

Simulator information is entered into the header area of the SYSCON.DAT file in two stages. Task SHOTNO requests and stores a one- to four-digit shot number and a two-character simulator code, which should be "02" for the Oil Water Line II, SGEMP Simulator (OWL II). The second stage takes place with task TABIN, which has two modes of input, a special one (for 02) and a general one.

Special (02) mode

Wire type (two characters)
Pulse charge (megavolts)
Tank vacuum (torr)
Voltage diode peak (volts)
Current diode peak (volts)
Comment (30 characters)

General mode

Configuration code (two characters)
Output level (units not yet established)
Comment (30 characters)

Space in the SHOT.DAT file has been provided for user comments. They are logged on the transmitter log for the shot to follow. The task used to enter them is USRCOM. It expects 64 characters or fewer.

In all terminal entries, except the digitizer unibus address in input to the CONGEN file, standard SASP terminal input conventions apply.

3.3 Terminal Input Conventions

A line of input is read in by subroutine INPUT. This line consists of fields (or columns) separated by control I or TAB. The first field begins with the first character. Each subsequent control I begins a new field, irrespective of preprinted column headings.

The three forms of input--American Standard Code for Information Interchange (ASCII), integer, and floating point--are retrieved from the input buffer by subroutines ASDCD, FXDCD, and FLDCD, respectively. The choice of field is made by a field-number parameter. See the individual documentation for each subroutine. The DEC terminal input line-editing commands, control U and RUBOUT, are still operative.

For a given field, there are three null conditions:

a. The input was terminated (carriage return) before the field was reached.

b. The field was reached, but a second control I was given immediately.

c. The first character of the field was a blank.

Under conditions a and b, the value stored before input remains untouched. Condition c causes a zero to be stored.

3.4 Data-Taking Sequence

3.4.1 TESTSEQ Operations Control Program

The SASP data-taking sequence is controlled by indirect command file DK0:[100,100] TESTSEQ.CMD. (For general information on indirect command files, see the Operator's Procedures Manual for DEC RSX-11M.[2]) Decisions by the operator are entered by means of yes (Y) or no (N) answers to preprogrammed questions. Operations are carried out by tasks executing on command RUN from TESTSEQ. Many tasks require operator input or provide output. Pauses in command file processing are placed at crucial points; the system is then under the direct control of the operator.

If abnormal conditions require exiting from TESTSEQ's control, typing control C and a carriage return (CR) "punches through" to the system. If TESTSEQ has paused, is waiting for an answer to a question, or is printing comments, the operator types ABO AT. (CR). If command RUN was the last line issued, the operator types ABO TTO (or TTI for the DEC LA36 Teletype terminal), and, immediately after the task termination message, TESTSEQ is in control. The procedure must then be repeated. If ABO TTO was needed and the task running referenced a data file, the file may be locked. As soon as possible, the operator uses the DEC utility PIP to unlock the files.

Any task that references the digitizers or the transmitters may produce error messages at the terminal. The standard SASP digitizer and channel error codes apply (see app A for details).

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[2] *Operator's Procedures Manual RSX-11M Version 2, DEC-11-OMOGA-B-D, Digital Equipment Corp., Maynard, MA (September 1975).*

Before the data-taking sequence can begin, a few operations must be performed or confirmed. The RSX-11M operating system must be running from a suitable system disk: one that has all the needed SASP tasks, DEC utility tasks, and SASP data files. A data disk with sufficient storage space must be mounted; if it is not, the operator makes room or initializes a new one. The correct time and date should be entered with the monitor console routine (MCR) command TIME. The UIC should be set to [100,100] with the MCR command SET.

Shot files are to be transferred to magnetic tape as quickly as possible. Also, at some established interval (such as once a day), the master data tapes should be updated.

Figure 11 is the flowchart for TESTSEQ. Errors during task BASE should be resolved before continuing. Besides acquiring baselines, this task is meant to act as a screen for all potential problems at other, more crucial steps in the process. The TESTSEQ Operations Control Program (app C) can be used as an aid to understanding the flowchart. Individual task documentation in the SASP Programmer's Handbook, as well as the source listings (SASP.SOURCE), also will prove helpful.

3.4.2 Manual Data Acquisition Procedures

Care must be taken when TESTSEQ is abandoned and data-taking instructions are entered manually. The operator should be very familiar with the processes. He should never run task SCALE without running task CHKCAL to screen out bad (incorrect) data link gains. The operator sets the shot number with task SHOTNO before producing any output. He runs task TABIN to rename the MAIN.DAT file before running task OUTFIL to create the next main data file. The operator should always run task PREDAT before task DATA or DATAPC and be sure that the error flags represent a desired and proper status.

3.4.3 Disk Preparation

The following summarizes the instructions for preparing a new data disk.

Initializing a new data disk

<u>DMO DK1:</u>
(Remove old data disk; put new one in place.)
<u>BOOT PRESRV</u>
(write-protect DK0:)

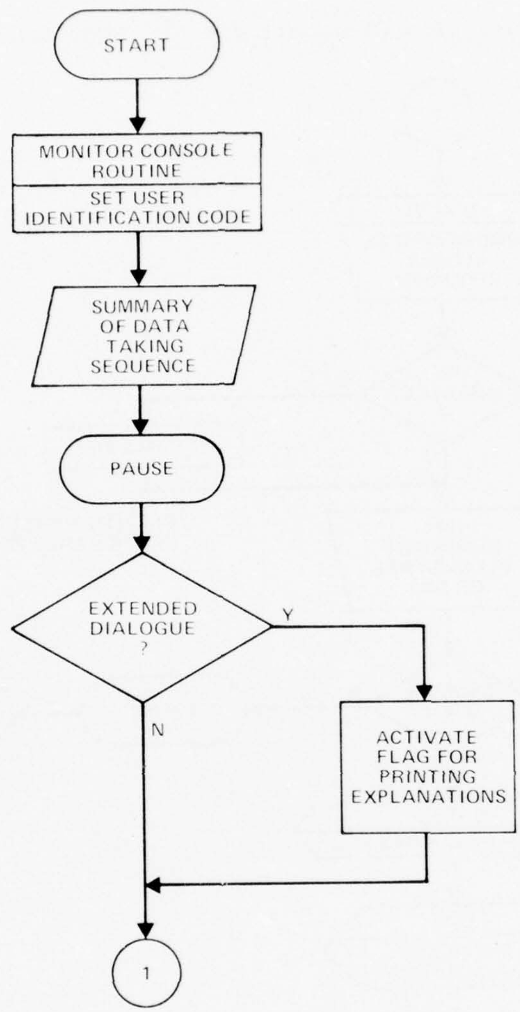


Figure 11. Flowchart for TESTSEQ.

Figure 11. Flowchart for TESTSEQ (Cont'd).

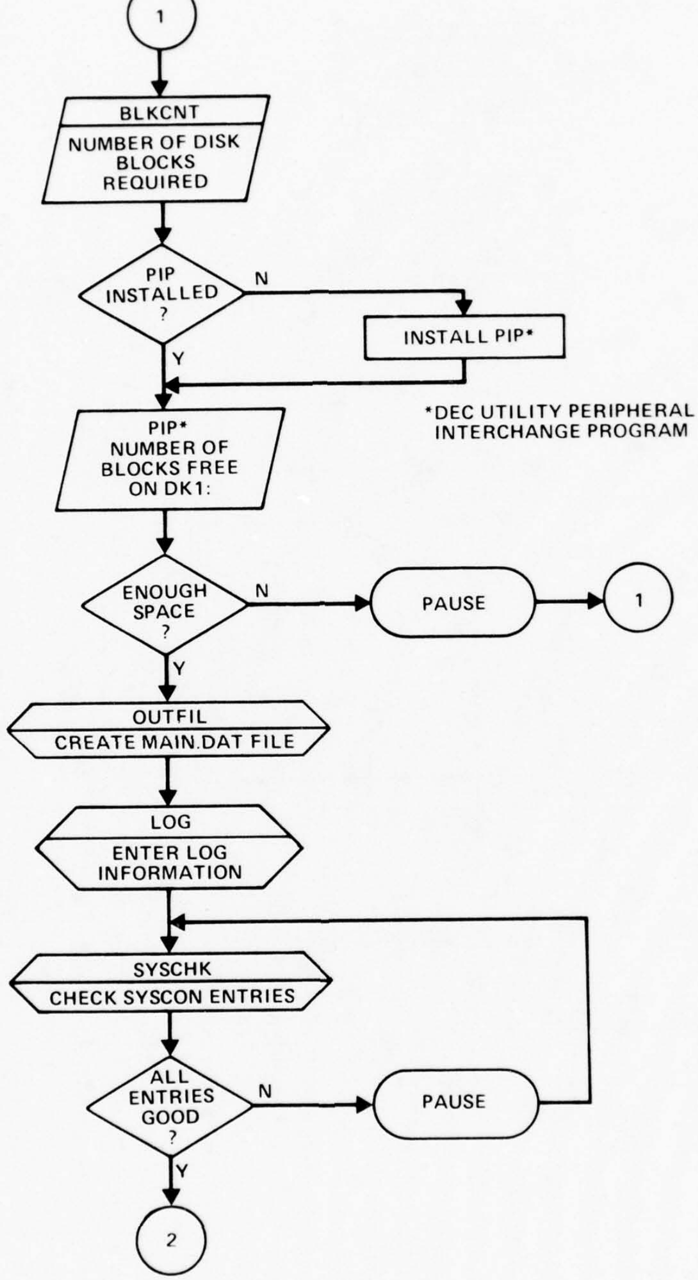


Figure 11. Flowchart for TESTSEQ (Cont'd).

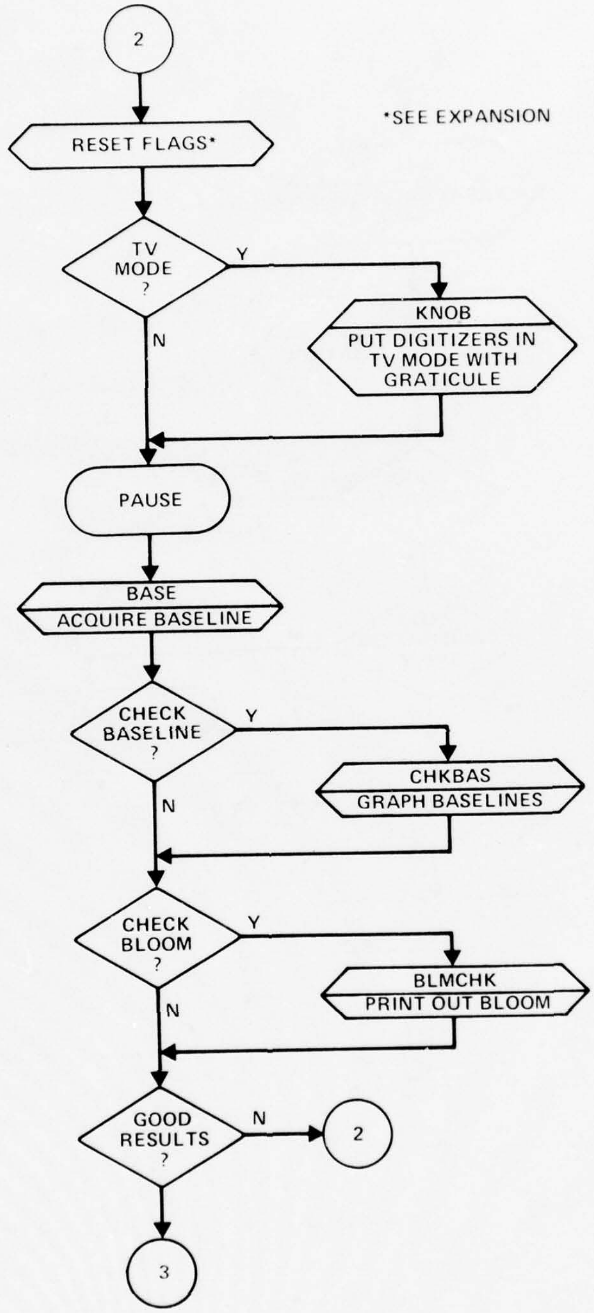


Figure 11. Flowchart for TESTSEQ (Cont'd).

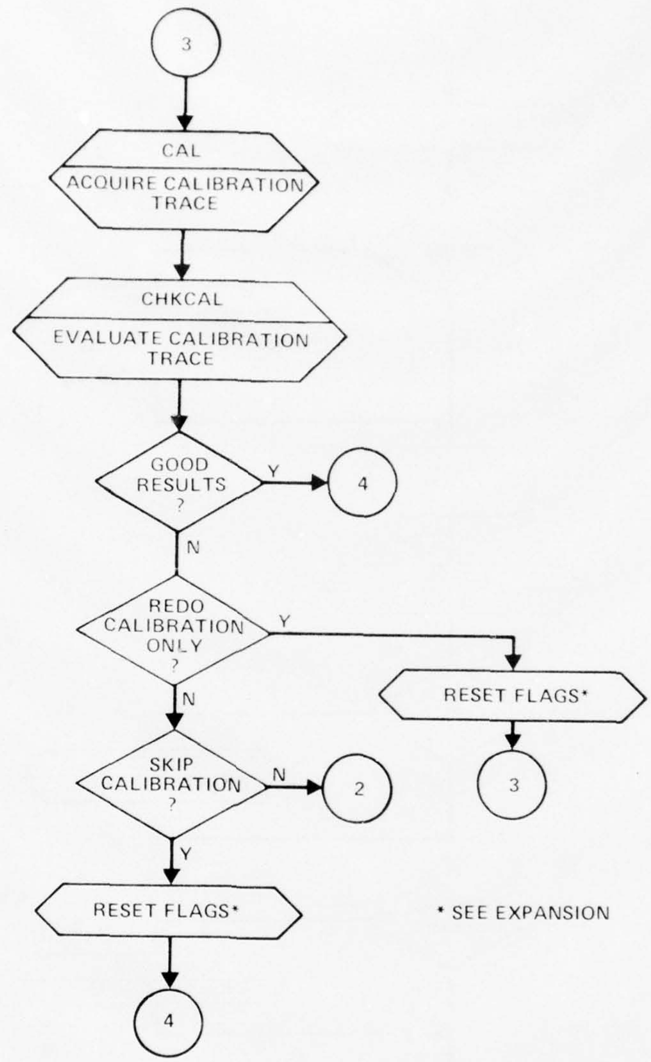


Figure 11. Flowchart for TESTSEQ (Cont'd).

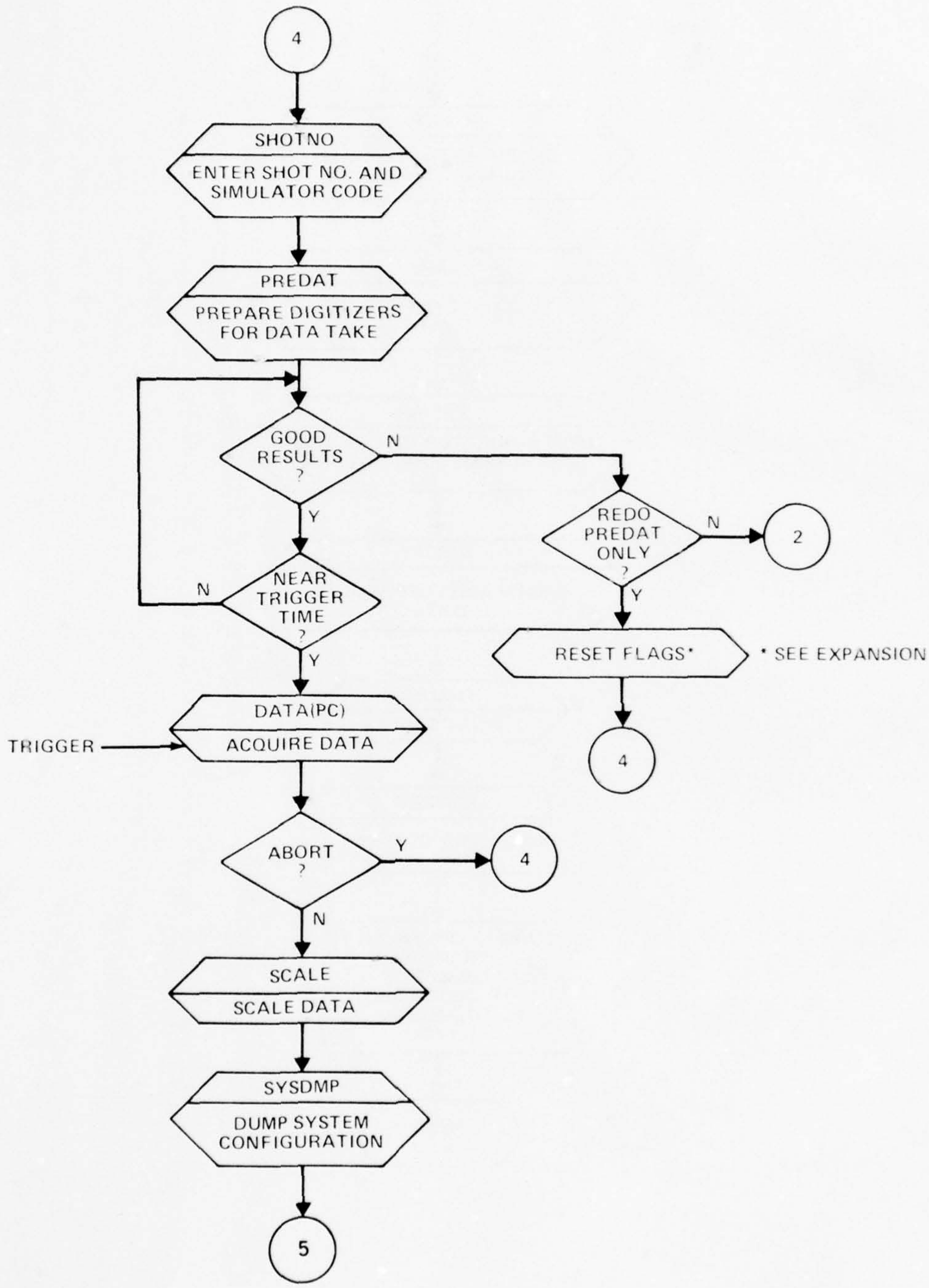


Figure 11. Flowchart for TESTSEQ (Cont'd).

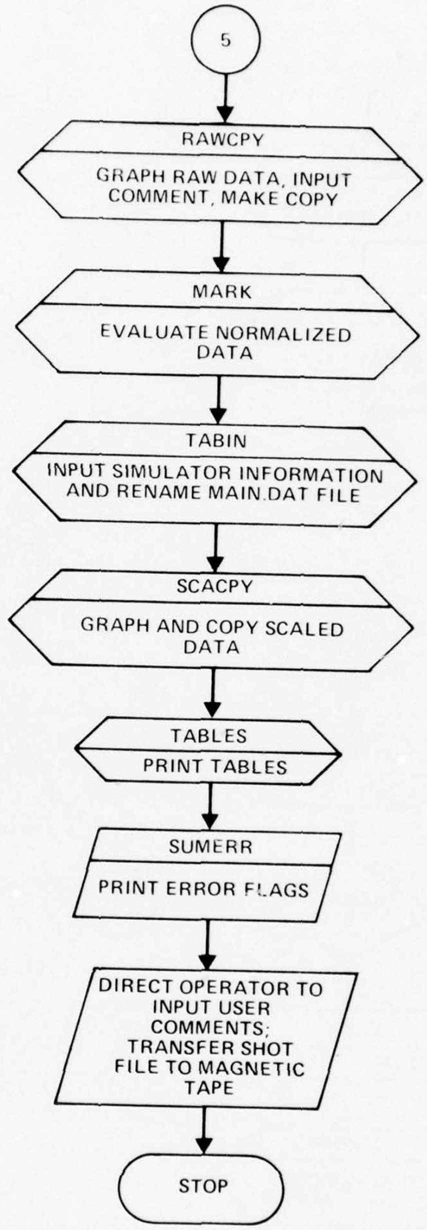
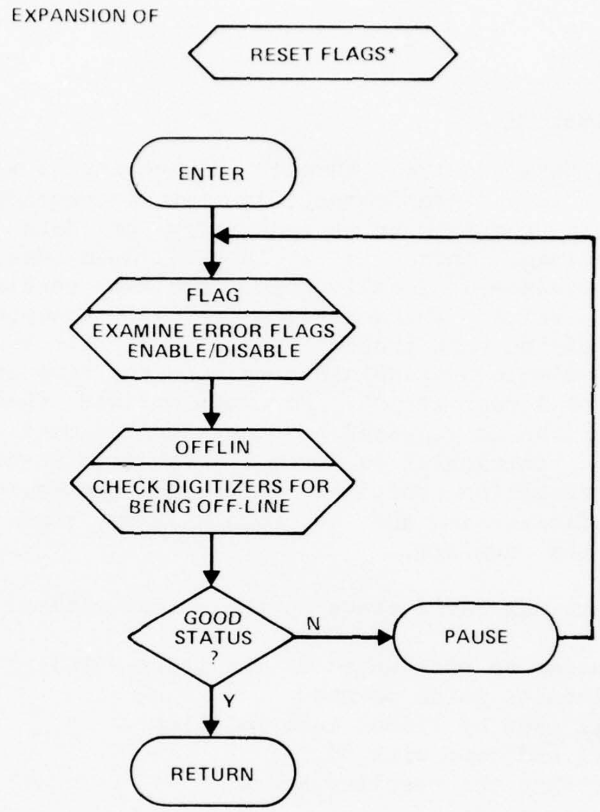


Figure 11. Flowchart for TESTSEQ (Cont'd).



PRE>DK1:/FO
(Load RSX-11M operating system when formatting is complete.)
.
.
.

@ EOF
TIM HH:MM MM/DD/YY
BAD DK1:
INI DK1:/BAD=[AUTO]
MOU DK1:
UFD DK1:[100,100]

Operator input is underlined above. If the new disk has actually been previously used, the contents will be lost.

4. DATA PROCESSING

4.1 Normalization

The raw data acquired through digitizing a waveform with the digitizer are not in a form compatible for processing by a digital computer. Usually, there is an overabundance of data describing the waveform. Sometimes, there is a lack of data describing certain portions of the waveform. Ideally, there are two vertical values for each horizontal value. These vertical values correspond to the upper and lower edges of the path traced by a beam as it sweeps across the target. Here, a simple average can determine the true center of a trace to a resolution of 1 part in 320. For more or less than two vertical values, an algorithm is required to determine the most likely center of a trace for that particular point on the raw data waveform. It is the task of the normalization routines to process the raw data, with their excesses and deficiencies, and to obtain from them a more usable presentation of the waveform.

There are six basic steps to the normalization:

a. Average to the center of the trace (ATC).
b. Eliminate noise points.
c. Fill gaps by linear interpolation.
d. Fill end gaps with "0."
e. Subtract the baseline trace.
f. Subtract "256."

For baseline traces and calibration traces, these steps are carried out with integer arithmetic. Data-trace normalization uses floating point operations. Step e is not used for baseline traces. In step d, a baseline trace is extrapolated rather than filled with "0."

a. The ATC reduces the raw digitizer data to, at most, a single vertical value for each horizontal value. The original raw data are composed of horizontal and vertical values in a one-dimensional array. The vertical values that are associated with a horizontal value follow it. Each such group is in order by horizontal value, except that the data start at an arbitrary horizontal position of the target and wrap to the starting point. Horizontal values are differentiated from vertical ones by having the bit in entry HZMSK set (app D). ("HZMSK" is defined as 1000_8 by the SYMDEF macro, a macro routine used to initialize all SASP parameters. See app D.) Points flagged with the bit in entry

BADBIT are excluded from consideration. ("BADBIT" is defined as 10000_8 by the SYMDEF macro.) If a horizontal value is flagged as bad, it is assumed that the associated vertical values also are bad. Vertical values are recorded from the top of the target to the bottom.

Once a vertical value is masked with entry DTAMSK, its value is the vertical position on the target and is in the range of 0 to 511. When a horizontal value is masked, the result is the complement of the position on the target. The complement also is in the range of 0 to 511. The coordinates (0,0) correspond to the lower left-hand corner. Each horizontal-vertical group is resolved into a horizontal value with a single vertical value.

The ATC routines consider four groups: (1) a single vertical value, (2) two vertical values, (3) three vertical values, and (4) four or more vertical values. Each group is considered independently.

Group 1.--It is assumed that the bottom edge of the trace was missed due to the dead time of the read gun; the dead time is equivalent to the time for the scan gun to read four points. The single vertical value is then shifted down slightly by subtracting "2."

Group 2.--The separation of the two vertical values is compared to entry BLMFAC times the bloom parameter. If the separation is less than this product, the two are averaged. If not, the separation is flagged as a gap point.

Group 3.--The closest pair is chosen, and the conditions of group 2 are applied.

Group 4.--Four or more vertical values are immediately flagged as a gap point. The flag for a gap point is "-1." All well-defined vertical values are from 0 to 511.

Since the bloom parameter used in groups 2 and 3 is calculated from the baseline trace (see documentation for subroutine BASATC in the Programmer's Handbook), the baseline ATC requires a simplified approach. Group 1 remains the same. For group 2, the averaging takes place automatically. Groups 3 and 4 result in gap points.

b. The trace is now a single dimensional array of 512 vertical values and gap points with the horizontal value being implied by the subscript of a particular vertical value. This array is now scanned for

where the slope between two vertical values is greater than entry TANMAX in absolute value. The value of TANMAX is to be chosen so that it represents the writing rate limit of the digitizer. Of any pair found to have a slope greater than TANMAX, the second value of the pair becomes a gap point. It does so if the first value of the pair is valid and the trace could not actually move from there to the second point.

c. Steps a and b have probably produced at least a few gap points. These are filled by linearly interpolating between the vertical values that remain.

d. The gap points at either end cannot be interpolated. Except for the baseline, extrapolation does not seem suitable. The gaps at the ends of the calibration and data traces are set so that they are "0" after steps e and f. The baseline is extended by averaging the five valid vertical values at the end and using that average for the gap points at that end.

e. The baseline trace is subtracted, point for point, from the calibration trace and the data trace.

f. The value "256" is subtracted from each vertical value to place "0" at the center line.

The following subroutines are used:

Step	Subroutine	Type of trace
a	BASATC	Baseline
	CALATC	Calibration
	DATATC	Data
b	ELIMPT	Data
	QKELIM	Baseline, calibration
c	INTRP	Data
	QKLNTP	Baseline, calibration
d,e,f	EXTRAP	Baseline
	ISBASE	Calibration
	SUBASE	Data

4.2 Data Evaluation and Characterization

During the data-taking sequence, four types of data are available for evaluation: baseline, calibration, raw, and normalized. The tasks used to plot these data are CHKBAS, CHKCAL, RAWCPY, and MARK, respectively. The STARS operator is responsible for reviewing the data for quality and completeness. He is not typically an experimenter and, therefore, cannot be expected to judge the data in the context of the experiment. Instead he should comment on data deficiencies or excesses relatable to hardware misuses, limitations, or malfunctions.

Data are characterized in task MARK (sect. 4.2.4). There, key parameters of interest to the experimenter are marked with the graphic cursor by the STARS terminal operator.

4.2.1 Baseline Data

Prior to an actual experiment (simulator shot), baseline data must be acquired from each digitizer so that the proper intensity setting for each digitizer may be determined. Through use of the TV monitor, the baseline may be observed while the position and intensity are adjusted. Then task BASE is run to digitize, acquire, normalize, and store the baseline data on a disk. If any intensity settings were incorrect, an appropriate error message appears on the terminal.

Typical error messages are "BLM"--bloom too large or too small--and "SHF"--baseline trace position not as requested. "BLM" indicates that the intensity setting for that digitizer was either too high or too low. This setting can be corrected by adjusting the intensity and rerunning task BASE. "SHF" is usually caused by an incorrect baseline position. Repositioning the baseline and rerunning task BASE corrects this error. (App A lists and discusses error codes.)

Baseline data are used primarily for two purposes: (1) the baseline waveform is subtracted from the calibration and experiment data waveforms to remove any nonuniformities, such as baseline tilt, and (2) monitoring the baseline is a quick method of determining if the digitizers are functioning properly and the desired knob settings are correct. The turnaround time for task BASE is typically less than 2 min.

If several attempts at acquiring a baseline on one or more digitizers do not produce the desired result, two separate tasks are available as diagnostics. Task CHKBAS can be used to graph the baselines on the console display, and task BLMCHK can be used to print the bloom parameter for each digitizer on the line printer. Once error flags are noted, they must be reset by running task FLAG before new

baselines can be acquired from the suspect digitizers. If a digitizer or channel error flag is not reset, no data from that digitizer or channel are processed or output in any subsequent routine in the current production run.

4.2.2 Calibration Data

A calibration waveform is obtained from each optical transmitter calibration generator. The calibration pulse amplitude as recorded at the digitizer is a measure of the optical data link gain. In task CHKCAL, calibration waveforms for each channel are plotted on the terminal. The peak amplitudes of these calibration pulses are standardized so that the terminal operator can quickly judge their validity. Thus, the calibration pulse serves as a channel performance check prior to the actual data take. The operator can optionally disable any channel in the system. If the calibration pulse shape and amplitude appear correct, the peak value is computed automatically, and the data link gain is calculated and stored in the proper disk file.

4.2.3 Raw Data

Task DATA is used to acquire the raw data from the digitizers and store the data on a disk. Raw data are the multivalued function read directly from the digitizer target (fig. 12, p 47). Although they are not useful for mathematical machine computations in this format, the raw data are very useful to the experimenter for a quick look and to the terminal operator in determining if the digitizer writing rate has been exceeded. Task RAWCPY plots the raw data for each digitizer and permits entry of an operator comment prior to producing a hard copy. These raw data are made avaialble to the experimenter within minutes after the shot. At this stage in data evaluation, an experienced operator can predict the success of the normalization in upcoming tasks.

4.2.4 Normalized Data

During data taking, the first opportunity to view the normalized data occurs in task MARK. With the normalized, unscaled data graphed on the terminal, the operator evaluates and parametizes the data waveforms (fig. 13, p 48). First, a preprogrammed message is printed instructing the operator to sequence the graphic Y cursor to three points of interest on the data plot. The time values of these points are then transferred to the main data file on the disk. (Because the data are stored as amplitudes in a 512-element array comprising equal time intervals, knowing the time or array index is sufficient for determining the corresponding amplitude). Next, the operator is prompted to enter a suggested gain or attenuation for the upcoming shot. The program calculates the required gain or attenuation for on-screen

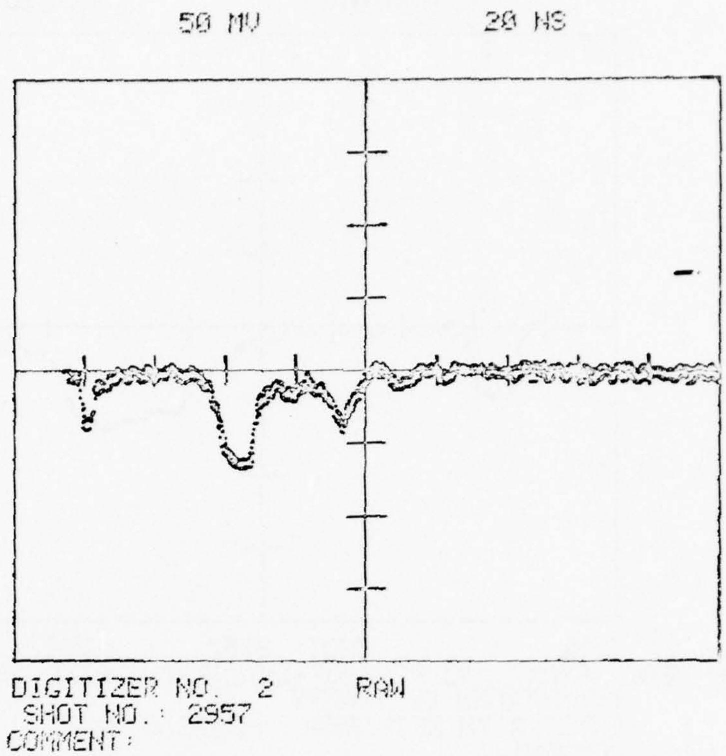


Figure 12. Raw data, sample 1.

waveforms (on the digitizer target) and prints this suggested value in the parentheses as shown in figure 13. Lastly, the prompt appears for a comment to be entered. Comments may be up to 24 characters long.

The waveforms graphed in task MARK reflect raw data that have undergone the entire normalization. At this stage, hard copies of the raw data have already been printed and can be directly compared one to one with their normalized counterparts in task MARK. Copies of the unscaled, normalized data are not generally retained; however, they could be reproduced later.

4.3 Typical Production Run

On each shot, the experimenter is provided with a system configuration printout (fig. 14), which gives the date and time of the event, a synopsis of equipment used on the event, and the output of the two calorimeters associated with the STARS.

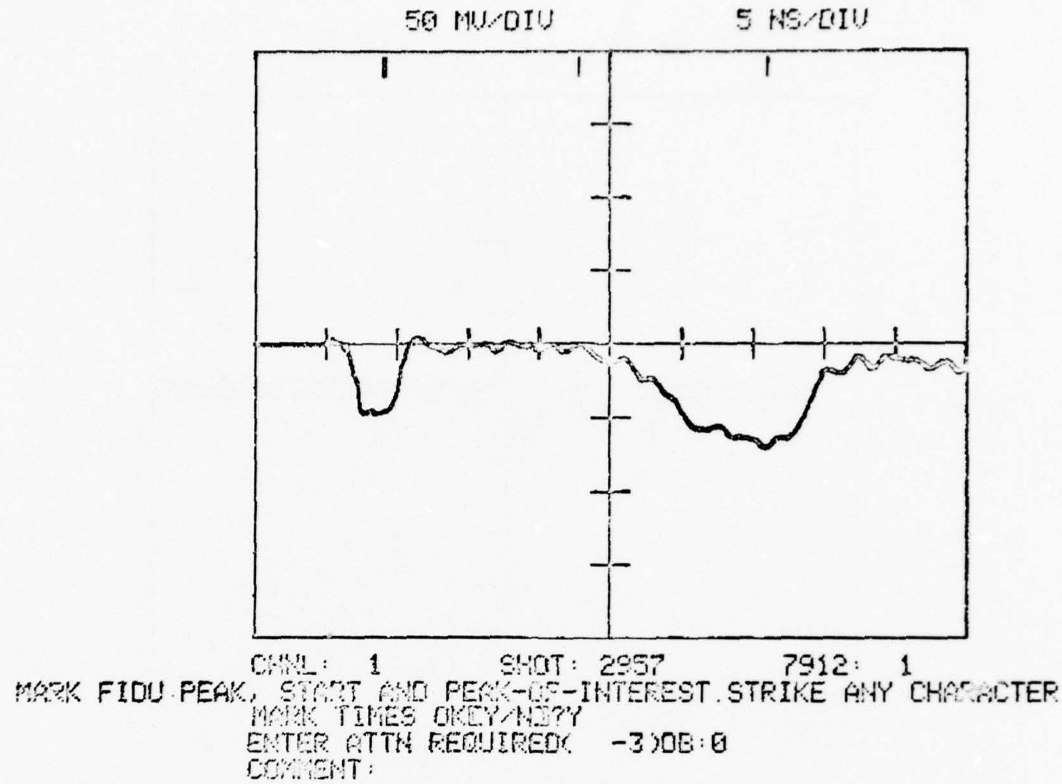


Figure 13. Normalized data.

Within 5 min after the event, the experimenter is given a copy of the raw data for each digitizer (fig. 12, 15). He can quickly estimate the magnitude by dividing the number of digitizer volts by the "factor" given in figure 14. The raw data are annotated with the shot number and the digitizer parameters.

Within 30 min, the experimenter is given a copy of the scaled data (fig. 16) in the units desired by him. Accurate timing between channels is possible by referencing the marker pulse (fiducial) at the left edge of all data traces. The STARS operator marks each trace with the location of the fiducial marker, the start time of the data, and the time of the peak of interest. Vertical timing tick marks indicate the exact locations of these parameters on the scaled data plot. Annotation of several key parameters, such as the coded test point name, also is provided for each plot.

```
SYSTEM CONFIGURATION

TRIGGER DATE AND TIME:      76      8      12         11      46      2

SHOT NO:     2957      2957

NO. OF 7912'S, BOARDS AND CHNLS:       4       2       2

WDN'S & NO. OF BLOCKS:       6      14      22      54      70      71      71

SIM. CODE & DATA:   02  1    0.4220000E 01   0.9999999E-04   0.0000000E 00   0.0000000E 00

COMMENT:

CALORIMETER DATA:    0.1302019E-04     74   0.2021739E-03     100      0


7912  ADDRESS    CHNL    FLAG   SWEEP    VERT   BLOOM  OFFSET

  1    164040      1       0       5      50      6       0
  2    164050      1       0      20      50      8       0
  3    164060      2       0       5      50      4       0
  4    164070      2       0      20      50      5       0


CHANL      FLAG    TEST POINT  ATTN  PROBE  BIAS    PRE-X DLY        DEVICE
         XMITTER  X-ATTN   POST-R DLY      POST-R GAIN  , 7912'S       1ST       2ND       3RD
                  GAIN             FACTOR               DELAY

   1         0     ALAU          DML2  I2          0   0.1000000E 01   TRN2
            16      -12   0.2000000E 01   0.0000000E 00        2         1         2         0
                  0.25277165E 02     0.2316636E-01      0.2283000E 03

   2         0     AGAU          DML1  I1          0   0.1000000E 01   TRN3
            20      -30   0.2000000E 01   0.0000000E 00        2         3         4         0
                  0.31659723E 02     0.6801152E-01      0.2283000E 03
```

Figure 14. System configuration printout.

In addition to receiving the raw data, scaled data, and system configuration printout, the experimenter is provided with a listing of the recommended attenuator settings for the next shot (fig. 17). This provision presumes that the same sensors will be recording at the same level of flux.

The final output consists of three figures: data parameters (fig. 18), system configuration (fig. 19), and digitizer parameters (fig. 20). With the scaled data, these figures provide a complete record of the shot in a format designed for data review, cross-referencing, and reporting.

Special output routines permit printing of the raw data, the calorimeter sample values, the baseline data, etc. Routines have been created also to allow for printing the contents of each of the calibration files; for example, figure 21 was generated by task PRB. Task PRB lists all the probes currently in the PRBCAL.DAT file and pertinent parameters for each probe.

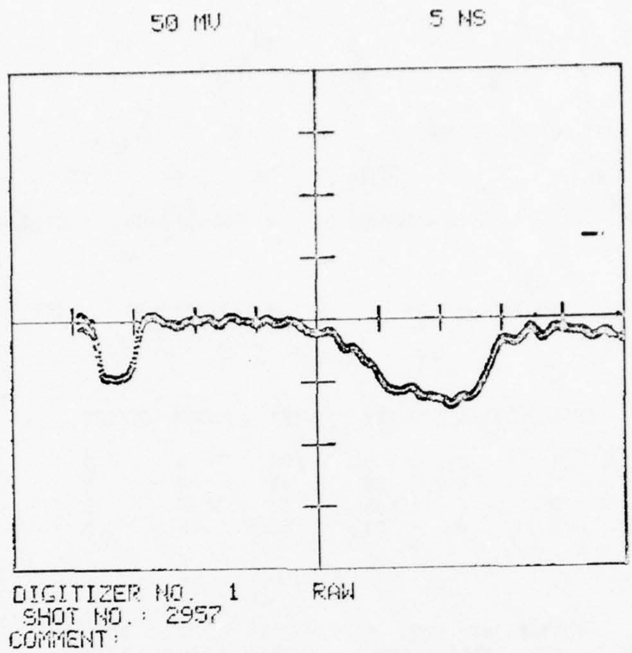


Figure 15. Raw data, sample 2.

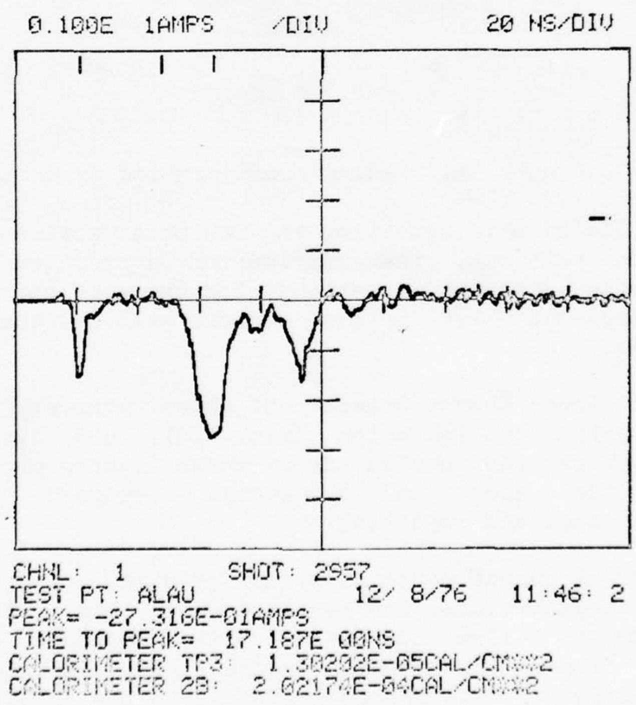


Figure 16. Scaled data.

TABLE OF RECOMMENDED ATTENUATOR SETTINGS: LAST SHOT: 2957

CHANNEL	PRESENT	CHANGE	RECOMMEND
1	-12	0	-12
2	-30	0	-30

Figure 17. Table of recommended attenuator settings.

TABLE 1: DATA PARAMETERS

SHOT 5647 21: 7:76 18:10:23 P1

TANK VACUUM 0.45000E 02 WIRE CODE: E1

COMMENTS: ASASASASASASASA

CHANNEL	DIGITIZER	TEST POINT	START TIME(MS)	PEAK TIME(MS)	PEAK	AREA
1	1	AAAAA	0.150E-38	0.000E 00	0.34897E-38	0.14923E-38
2	2	BBBBBBBB	0.255E-38	0.255E-38	0.33970E 38	0.33970E 38
3	3	CCCCCCCC	0.105E-20	0.150E-38	0.25200E-38	0.00302E 00

Figure 18. Table of data parameters.

TABLE 2: SYSTEM CONFIGURATION

SHOT 5647 21: 7:76 18:10:23 P1

TANK VACUUM 0.45000E 02 WIRE CODE: E1

COMMENTS: ASASASASASASASA

CHANNEL	TEST POINT	ATTENUATOR	SENSOR	DEVICE	XMTR ATTEN	SCALE FACTOR	CHANNEL DELAY
1	AAAAA	A001	B001	A006	-3	0.00000E-01	0.00000E-01
2	BBBBBBBB		B003	A004	-6	0.00000E-01	0.00000E-01
3	CCCCCCCC	A001	H034	DL01	-6	0.00000E-01	0.00000E-01

Figure 19. Table of system configuration.

TABLE 3: DIGITIZER PARAMETERS

SHOT 5647 21: 7:76 18:10:23 P1

[illegible]UUM 0.45000E 02 WIRE CODE: [illegible]

COMMENTS: ASASASASASASASA

DIGITIZER	CHANNEL	SWEEP SPEED(NS/DIV)	SENSITIVITY (MV/DIV)	BASELINE OFFSET(MINOR DIVS)
1	1	20	50	5
2	2	20	50	-9
3	3	20	50	2

Figure 20. Table of digitizer parameters.

ID	XFER(DB)	DLY(NS)	FLAG	BLN	UNITS	MT	PARAMETR	MODEL	MFR S/N	CONNECTOR
B501	-140.03	2.63	1	1	GAUSS	BD	0.10E-02	CMLX5AR	1	2 SMA 50
B506	-140.03	20.00	1	1	GAUSS	BD	0.10E-02	CMLX5AR	6	2 SMA 50
B310	-146.06	10.75	1	1	GAUSS	BD	0.50E-03	CMLX3AR	10	2 SMA 50
B301	-146.06	2.45	1	1	GAUSS	BD	0.50E-03	CMLX3AR	1	2 SMA 50
B507	-140.03	20.00	1	1	GAUSS	BD	0.10E-02	CMLX5AR	7	2 SMA 50
EAU	-5.93	0.00	0	2	V/M	E	0.50E-02	PMD-1	13	1 SMA 50
I1	0.00	0.30	0	2	AMPS	I	0.50E 00	CT-2	1	1 SMA 50
I2	0.00	0.30	0	2	AMPS	I	0.50E 00	CT-2	2	1 SMA 50
B308	-146.06	10.88	1	1	GAUSS	BD	0.50E-03	CMLX3AR	8	2 SMA 50
B309	-146.06	9.25	1	1	GAUSS	BD	0.50E-03	CMLX3AR	7	2 SMA 50
EAG	-5.93	19.00	0	2	V/M	E	0.50E-02	PMD-1	17	1 SMA 50
EGLY	-5.93	19.50	0	2	V/M	E	0.50E-02	PMD-1	16	1 SMA 50
OPEN	0.00	0.00	0	1	VOLTS	V	0.00E 00	[illegible]	[illegible]	[illegible]

TOTAL NO. OF PROBES: 13 08:35:57 11-AUG-76

Figure 21. Probe file listing.

4.4 Storage and Retrieval

Storage requirements can be estimated by using the format of the SHOT.DAT file given in section 2.2 and the following file entry information:

Type of data	Storage (256-word blocks)
Copy of SYSCON.DAT file	5
Baseline data	2
Calibration data	2
Raw data	8
Scaled data	4
Parameter entry	1/4
User comment entry	1/8

For example, if 15 digitizers were being used, the file size or disk space requirements would be as follows:

$$5 + 2n + 2n + 8n + 4n + n/4 + n/8 = 5 + 16.375n$$

$$= 5 + 16.375 \times 15$$

$$= 250.6 \text{ blocks .}$$

Further, assume that 10 simulator shots (10 SHOT.DAT files) are to be recorded: $10 \times 250.6 = 2506$ blocks. The disk pack used to store these data contains 1.2 million words. Therefore, a disk pack contains $1.2 \times 10^6/256 = 4687$ blocks. For a typical test period of several weeks, some other form of off-line storage is indicated. The STARS uses nine-track tape compatible with that used in industry.

At the end of each day's testing the data disk contents are transferred to a 183-m magnetic tape. This tape then becomes the day file. After several days of testing or at some scheduled interval, the day files are copied onto a 732-m master data tape. This master data tape is then copied to provide a backup. The day files are retained until the end of the current test program. At that time, they may be erased and reused on the next test program. A test program typically lasts from 2 to 3 weeks. The data from this program should fit on a single reel of 732-m tape. Backup copies of all master data file tapes are retained. These tapes then comprise the STARS data bank.

Certain features have been incoporated into the SHOT.DAT file structure to facilitate searching. In the SYSCON header entry of the SHOT.DAT file (fig. 3), virtual block number entries point to the first entry of each type shown. For example, on shot No. 2937 for digitizer No. 1, the sequence for obtaining the raw data would be as follows:

a. The operator locates either the day file tape or the master file tape containing shot No. 2937 and installs the tape on the nine-track tape unit.

b. The operator uses the appropriate program to search for the proper file. For example, the SHOT.DAT file may be "S293702.DAT." The "02" is the simulator code for the OWL II simulator. The "S" and the "DAT" are always the same.

c. The operator transfers the data to the disk.

d. The SYSCON header in the S293702.DAT file contains an entry entitled "VBN, RAW" which is an integer representing the block number within the S293702.DAT file of the raw data of digitizer No. 1. Reading forward eight blocks transfers the data of interest. (Raw data are always eight blocks in length.)

Another example is the test point name contained in the SYSCON channel entry of the SHOT.DAT file. The test point name permits nine ASCII characters that can be coded into representing some important parameters of the test. For example, three digits can be used to code 1000 different locations or test point descriptions, two digits can denote the measurement type, and two digits can denote the simulator orientation and type. This type of coding facilitates search algorithms.

5. BRIEF MODULE DESCRIPTIONS

This section presents a short synopsis of each task and subroutine in SASP. Detailed descriptions of each module can be found in the SASP Programmer's Handbook. Indirect command file TESTSEQ is discussed in section 3.4.1. Physically, the subroutines and macros have been, wherever possible, grouped logically into object and macro libraries resident on the system disk (app E).

Indirect command files	Function
TESTSEQ	Control data acquisition and processing program execution.

Task	Function
ATN	Generate, modify, and print contents of ATNCAL.DAT file.
BASE	Acquire, normalize, and store baseline for each enabled digitizer.
BLKCNT	Print number of blocks required for SHOT.DAT file (such as MAIN.DAT and Snnnnxx.DAT).
BLMCHK	Quickly look at digitizer entries in SYSCON common area in core.
CAL	Acquire, normalize, and store calibration trace for each enabled digitizer.
CHKBAS	Plot baseline data.

Task	Function
CHKCAL	Plot and evaluate calibration waveforms, compute optical link gain, and input comments.
CONGEN	Generate SYSCON.DAT file and initialize transmitter and digitizer addresses.
DATA	Acquire and store raw data trace for each enabled digitizer; acquire and analyze calorimeter data.
DATAPC	Same as DATA, plus print raw calorimeter data.
ERASE	Erase screen of terminal or give eight line feeds on LA36 Teletype terminal.
FIXNPT	Allows partial recovery from overflow condition on data trace; fix data point count of raw data at 2000; on overflow, store first 2000 points read.
FLAG	List digitizer and channel error flags and allow enabling or disabling.
KNOB	Switch all enabled digitizers to knobsetting mode (TV and graticule).
LOG	Input log information to SYSCON.DAT file.
MARK	Plot and characterize normalized data waveforms, compute and print recommended attenuator settings for next shot, and input comments.
OFFLIN	Test each enabled digitizer for off-line condition.
OUTFIL	Create MAIN.DAT file.
PRB	Generate, modify, and print contents of PRBCAL.DAT.
PREDAT	Prepare enabled digitizers for data taking (required precursor for DATA or DATAPC).
PRTNAM	Print name of SHOT.DAT file to which SYSCON.DAT file points.
RAWCPY	Plot, annotate, and comment on raw data waveforms.
SCACPY	Plot, annotate, and rescale scaled data waveforms.

Task	Function
SCALE	Normalize and scale raw data traces, calculate overall scale factor and data link gain, and store results.
SHOTNO	Input simulator code and shot number to SYSCON.DAT file.
SUMERR	Print digitizer and channel error flags.
SYSCHK	Check validity of certain entries in SYSCON.DAT file.
SYSDMP	Quickly dump contents of SYSCON.DAT file.
TABIN	Input simulator information to SYSCON.DAT file, copy SYSCON.DAT file into MAIN.DAT file, and rename MAIN.DAT file to current SHOT.DAT file name.
TABLES	Generate three tables of user-oriented tabular output data.
USRCOM	Input user comments to SHOT.DAT file.
XCH	Generate, modify, and print contents of XCHCAL.DAT file.

Subroutine	Function
ABSPKV	Compute absolute peak value of ATC array.
ANOMRK	Annotate MARK (unscaled, normalized data).
ANOSCA	Annotate parameters on scaled data.
ANSWER	Input and decode "yes" or "no" answer from console.
ASDCD	Transfer selected ASCII field from input buffer.
ATNREF	Handle reference to ATNCAL.DAT file.
ATNSCH	Read ATNCAL.DAT file for entry of selected device.
BASATC	Perform ATC for baseline trace, including bloom calculation.
BUSY	Wait for the clearing of busy status of digitizer.
CALATC	Perform ATC for calibration trace.
CALCSF	Calculate overall scale factor and data link gain.

Subroutine	Function
CALIB	Control transmitters during acquisition of calibration trace.
CHKTRG	Check each enabled digitizer for trigger interrupt.
CHNERR	Flag channel errors.
CLRCBD	Clear digitizer controller boards' status words, thereby disabling interrrupts.
CMDDIG	Send selected command to all enabled digitizers and confirm its execution.
DATATC	Perform ATC for data trace.
DATFIO	Handle input and output to MAIN.DAT and SHOT.DAT files.
DCDBIT	Generate table of codes corresponding to bits set in given word.
DIGERR	Flag digitizer errors.
DISABL	Set disabled flag in digitizer or channel error word.
ELIMPT	Eliminate noise points from data trace of ATC.
ERRNUM	Return bit number of left-most bit set in given word.
EXTRAP	Extrapolate ends of baseline trace and subtract "256" from entire baseline trace.
FIELD	Set pointer to selected field in input buffer and count characters in field.
FIXAMP	Calculate required attenuation changes for data channels.
FLDCD	Decode floating point number from selected field in input buffer.

Subroutine	Function
FLGPTS	Flag raw data points known to be incorrect.
FLOTE	Convert integer to floating point number.
FXDCD	Decode integer from selected field in input buffer.
GETBAS	Read, reduce, and store baseline trace for all enabled digitizers.
GETCAL	Read, reduce, and store calibration trace for all enabled digitizers.
GETDAT	Read and store raw data trace for all enabled digitizers.
GRAATC	Graph normalized floating point data.
GRABAS	Graph baseline data.
GRACAL	Graph calibration data.
GRARAW	Plot raw data.
GRASCA	Plot scaled data.
GRAT	Plot graticules on terminal in three sizes.
IASCII	Convert integer of less than five digits to ASCII.
IFICKS	Convert floating point number to integer (truncate).
INPCSR	Input data characterization parameters with graphic cursor.
INPUT	Input line from logical unit number (LUN) 5 to input buffer.
INT	Integrate scaled data by trapezoidal integration method.
INTABL	Enable digitizer interrupts.
INTDIG	Handle digitizer interrupts.
INTRP	Fill gaps in data trace by linear interpolation.
ISBASE	Subtract baseline trace and "256" from calibration trace.
LSTERR	List channel or digitizer errors.

Subroutine	Function
MINMAX	Search integer array for minimum and maximum values.
MRKCUR	Print cursor marks generated by subroutine INPCSR on scaled and unscaled data plots.
PAGE	Erase screen at terminal or give eight line feeds on LA36 Teletype terminal.
PLTSF	Annotate digitizer scale factors on baseline, calibration, ATC (normalized), or raw data plots.
PRBREF	Handle references to PRBCAL.DAT file.
PRBSCH	Read PRBCAL.DAT file for entry of selected probe.
PRICLR	Print raw calorimeter data.
QKELIM	Eliminate noise points from ATC of baseline or ATC of calibration trace.
QKLNTP	Fill gaps in baseline or calibration trace by linear interpolation.
RAWPLT	Condition raw data array for plotting by subroutine GRARAW.
RDIG	Read raw data from digitizer.
RDUKRO	Reduce knob readout information in raw data and compare it with desired settings.
SCADAT	Normalize and scale raw data traces and store results.
SCGEN	Create SYSCON.DAT file and write initial information.
SCIO	Read and rewrite SYSCON.DAT file into and from SYSCON common area in core.
SCMAIN	COPY SYSCON.DAT file into MAIN.DAT file and rename MAIN.DAT file to current SHOT.DAT file name.
SETVEC	Initialize digitizer interrupt vectors.
STCDAT	Transfer trigger date and time from TIME variable to SYSCON common area in core.

Subroutine	Function
SUBASE	Subtract baseline trace and "256" from data trace.
UCOUT	Write user comments into SHOT.DAT file.
XCHDRI	Read header records of XCHCAL.DAT file.
XCHREF	Handle references to XCHCAL.DAT file.
XCHSCH	Read XCHCAL.DAT for entry of selected channel.
XMIT	Control transmitters during acquisition of data trace.
.RSTR	Restore registers from stack.
.SAVE	Save registers on stack.

Macro	Function
RDSECT	Establish PSECT (program section) for RAWDAT common area.
SCSECT	Establish PSECT for SYSCON common area.
SYMDEF	Define commonly used symbols.

ABBREVIATIONS

ASCII	American Standard Code for Information Interchange
ATC	Average to center of trace
CR	Carriage return
DEC	Digital Equipment Corp.
DK0	Disk unit No. 0
DK1	Disk unit No. 1
LA36	DEC Teletype terminal
MCR	Monitor console routines
OWL II	Oil Water Line II, SGEMP simulator
4010	TEK main console graphic display terminal
RK11	System disk
RSX-11M	DEC operating system
R632	TEK television monitor
R7912	TEK transient digitizer, primary data recording device
SASP	SKYNET Applications Software Package
SGEMP	System generated electromagnetic pulse
STARS	SGEMP Transportable Automated Recording System
TEK	Tektronix
UFD	User file directory
UIC	User identification code
XRD	X-ray detector

APPENDIX A.--DIGITIZER AND CHANNEL ERROR CODES

A-1. SUMMARY

Both the digitizer and channel entries in the SYSCON.DAT file contain integer words or error flags, each bit of which (bit "0" to bit "15") is coded as shown below.

DIGITIZER ERROR WORDS

Number	Code	Meaning
0000	OFF	Off-line
0001	DIS	Disabled
0002	OVF	Data overflow
0003	UNF	Data underflow
0004	BZY	Busy status
0005	CMD	Command execution error
0006	TRG	*Failure to trigger*
0007	VFY	Reading verification error
0008	KRO	Bad (incorrect) knob readout
0009	BLM	Bloom too large or too small
0010	SHF	Baseline traced position not as requested
0011	(Unassigned)	
0012	(Unassigned)	
0013	NOB	No baseline trace
0014	NOC	No calibration trace
0015	NOD	No raw data trace

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APPENDIX A

CHANNEL ERROR WORDS

Number	Code	Meaning
0000	OFF	Off-line
0001	DIS	Disablement
0002	ATN	Attenuator setting verification error
0003	CAL	Bad calibration trace
0004 . . . 0015	(Unassigned)	

A-2. CAUSES AND RECOVERY

Following is a list of the digitizer and channel error codes, the conditions which cause the error to be generated, and the procedure to correct the faulty condition.

Digitizer error code	Cause	Recovery
0000	1. Digitizer is off or disconnected.	1. Turn on or reconnect digitizer.
0001	1. Digitizer is intentionally disabled (with task FLAG).	1. Reenable digitizer with task FLAG.
	2. Error is on associated channel.	2. Reenable digitizer with task FLAG.
0002	1. Too many points are stored in digitizer memory.	1. Decrease intensity or increase sweep rate (faster sweep speed).
0003	1. Too few points are stored in digitizer memory.	1. Ascertain proper trigger available and increase intensity, or both.

Digitizer error code		Cause		Recovery
0004	1.	Busy status exists.	1.	Allow digitizer to warm-up. Manually switch to digital and back to non-store on digitizer front panel.
0005	1.	Command is not executed because digitizer is not in proper status (such as single shot mode).	1.	Check digitizer front panel and plug-in switches for nonstore, single sweep, and external trigger.
0006	1.	Trigger cable is disconnected.	1.	Reconnect cable.
	2.	Trigger level and slope are improper.	2.	Readjust level and slope.
0007	1.	On TRYMAX entry separate attempts, second reading of digitizer memory had more than MISMAX entry words different from first reading.	1.	Repair digitizer after repeated errors
0008	1.	Setting of plug-in does not match that requested.	1.	Change request in SYSCON.DAT file with task LOG or change plug-in setting.
	2.	American Standard Code for Information Interchange (ASCII) readout is bad (incorrect).	2.	Repair ASCII. Temporarily reenable it and continue as though no error occurred. Ascertain that plug-ins are set as desired.
0009	1.	Intensity is too high or too low	1.	Adjust intensity and rerun task BASE.

Digitizer error code	Cause	Recovery
0010	1. Baseline position is incorrect.	1. Reposition baseline.
	2. Noise rides on baseline.	2. Check input signal.
	3. Noise point in digitizer is not eliminated by normalization.	3. Rerun task BASE.
0013	1. There was a previous error.	1. If previous error occurred before acquisition and reduction of baseline trace, there is truly no baseline; therefore, rerun task BASE after correcting error.
		2. If previous error was 0008, 0009, 0010, baseline data are stored and can be checked. Correct error and rerun task BASE.
0014	1. There was a previous error during task CAL	1. Follow directions for error 0013, using task CAL.
0015	1. There was a previous error during task DATA or DATAPC.	1. Follow directions for error 0013, using task DATA or DATAPC.

Channel error code	Cause	Recovery
0000	1. Transmitter is not connected.	1. Connect transmitter.
0001	1. Digitizer was intentionally disabled.	1. Reenable digitizer.
	2. Associated digitizer had error.	

Channel error code		Cause		Recovery
0002	1.	Transmitter attenuator did not respond properly.	1.	Manually override attenuator.
			2.	Repair attenuator.
0003	1.	Operator considered calibration trace to be wrong.	1.	Obtain good calibration trace with task CAL and recheck trace with task CHKCAL.

A-3. GENERAL

An error condition automatically prevents the unit and its associated data from being accessed further. All tasks examine the error word. Before any form of recovery is attempted or data are accessed, the operator should use task FLAG to reenable the unit.

If he desires to eliminate a digitizer from consideration, the operator should use task FLAG to disable the digitizer, thereby creating error condition 0001.

An error condition generates a disable error (0001) also on the associated units. The exception occurs when only one of two digitizers connected to a channel is in error. Under this condition, the channel is not disabled.

APPENDIX B.--DIGITIZER COMMANDS AND STATUS

A fairly comprehensive description of programming for the Tektronix (TEK) R7912 transient digitizer can be found in the appropriate Tektronix manual;[1] only the basics are described here.

These Digital Equipment Corp. (DEC) UNIBUS[2] addresses are used in programming:

$16x000_8$	Digitizer controller status word for card No. (X-3)
$16x0D2_8$	Digitizer command register for digitizer defined as having address $16x0D0_8$
$16x0D4_8$	Digitizer data and status register for digitizer defined as having address $16x0D0_8$

The controller status word content is defined as follows:

Bit	Definition
0	Interrupt pending
3,4,5	Device number ("D" of address) of interrupting device
6	Interrupt enable

The digitizer status word content is defined as follows:

Bit	Definition
0	Identity as TEK R7912 digitizer
1	Remote channel mode
2	Memory locked (write protect)
3	Graticule enabled

[1] *WDI TEK BASIC Software User's Manual, Tektronix, Inc., Beaverton, OR (1974).*

[2] *DEC PDP 11 Processor Handbook, 1975-76, Digital Equipment Corp. Maynard, MA (1975).*

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4	Single sweep armed
5	Single sweep mode
6	Channel 1 selected (if in remote)
7	Digital mode
8 to 12	(Not used)
13	Busy

The following are the digitizer commands where "x=0" equates to "clear," and "x=1" equates to "enable":

Command	Function
12000_8	Load memory, repetitive sweep only.
$20x2_8$	Inhibit knob readout output.
$20x3_8$	Select channel No. 1.
$20x4_8$	Select dot graticule.
$20x5_8$	Select digital mode.
$20x6_8$	Select remote channel mode.
$20x7_8$	Lock memory.
2020_8	Read status (status placed in status register).
2040_8	Arm single sweep.
2100_8	Read data (data word placed in data register as previous word moved out).
4000_8	Initialize registers.

For direct diagnostic control, commands may be entered at the front panel switches of the central processing unit by depositing the front panel switch contents to the command register address. The status is read by examining the status register. The DEC PDP 11/40 Processor

Handbook[2] describes the console operation. With the memory management option in place, the direct addresses are $76x0D0_8$ instead of $16x0D0_8$ although the virtual address for privileged tasks remains as $16x0D0_8$.

More complete diagnostic capabilities exist in the Waveform Digitizing Instrument TEK BASIC operating system loadable from a cassette. Both the cassette and the diagnostics are available at the System generated electromagnetic pulse Transportable Automated Recording System (STARS) facility to aid in troubleshooting TEK R7912 hardware problems.

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[2] *DEC PDP 11 Processor Handbook, 1975-1976, Digital Equipment Corp., Maynard, MA (1975).*

APPENDIX C.--TESTSEQ OPERATIONS CONTROL PROGRAM

The operator of the System generated electromagnetic pulse Transportable Automated Recording System (STARS) controls the data-taking sequence and the execution of all tasks by an indirect command file, TESTSEQ.CMD. This file is composed of all the tasks used to acquire, process, and store the data. By typing "@ TESTSEQ" followed by a carriage return at the operator console terminal, the complete directions for taking data are printed at the console display. The instructions lead the operator through the entire sequence and permit interactive control of task execution.

Following is a sample TESTSEQ file. It is similar to the TESTSEQ control program being used at the STARS. Reader familiarity with the command language of the monitor console routine of the Digital Equipment Corp. RSX11M operating system is a prerequisite to understanding the sample.

```
RUN ERASE
;THE FOLLOWING IS AN OUTLINE OF THE DATA TAKING SEQUENCE
;
;EVALUATE DISK SPACE AVAILABILITY (BLKCNT, VFY)
;CREATE MAIN.DAT (OUTFIL)
;RESET 7912/CHANNEL ERROR FLAGS (FLAG)
;CHECK FOR 7912'S OFF-LINE (OFFLIN)
;ENTER LOG INFO (LOG)
;CHECK LOG ENTRIES (SYSCHK)
;CORRECT ANY BAD ENTRIES (LOG, PRB, ATN)
;SET KNOBS (OPTIONAL TV MODE (KNOB))
;TAKE BASELINE (BASE)
;TAKE CAL (CAL)
;EVALUATE CAL (CHKCAL)
;ENTER SHOT NO. AND SIMULATOR CODE (SHOTNO)
;PREPARE 7912'S FOR DATA TAKE (PREDAT)
;TAKE DATA (DATA)
;NORMALIZE AND SCALE DATA (SCALE)
;HARD COPY RAW DATA (RAWCPY)
;EVALUATE DATA QUALITY AND SELECT KEY POINTS (MARK)
;INPUT SIMULATOR INFORMATION (TABIN)
;HARD COPY SCALED DATA (SCACPY)
;PRINT PARAMETER TABLE (TABLES)
;PRINT SYSTEM DESCRIPTION TABLES (TABLES)
;INPUT USER COMMENTS (USRCOM)
;PUT SHOT FILE ON DAILY DATA TAPE (PRTNAM, FLX)
;
;TASK NAMES ARE IN PARENTHESES.
```

```
        ;MAKE A COPY OF THIS PAGE IF ONE IS NOT AT HAND
        ;PAUSE
        RUN ERASE
        ;TO ELIMINATE SUPPLEMENTARY, EXPLANATORY TEXT,
        ;ANSWER THE FOLLOWING WITH N.
        ;ASK DIALOG EXTENDED DIALOGUE
        ;
.100:       ;DISK SPACE REQUIREMENTS
        RUN  BLKCNT
        ;IFNINS...VFY    INS...VFY
        .XQT   VFT    TTO: = DK1:/FR
        .WAIT
        ;
        .ASK SPACE IS THERE ENOUGH SPACE
        .IFT SPACE    .GOTO 200
        .IFF DIALOG   .GOTO 110
        ;DURING THE FOLLOWING PAUSE,
        ;MAKE USE OF PIP, FLX AND OTHER UTILITIES TO
.110:       ;CLEAN UP THE DATA DISK
        .PAUSE
        .GOTO 100

.200:       RUN OUTFIL
        .IFT DIALOG:MAIN.DAT HAS NOW BEEN CREATED
        ;
        ;PUT ATTENUATORS IN AUTOMATIC MODE
        .SETF REPCAL
        .SETF REPRED

.300:       RUN FLAG
        RUN ERASE
        .IFT DIALOG: NOW CHECKING FOR 7912'S OFF-LINE
        RUN OFFLIN
        .IFF DIALOG    .GOTO 310
        ;IF PRESENT ERROR CONDITIONS ARE NOT SATISFACTORY
        ;ANSWER THE FOLLOWING WITH N.
.310:       .ASK GOOD  GOOD STATUS
        .IFT GOOD    .GOTO 400
        .IFF DIALOG    .GOTO 320
        ;DURING THE FOLLOWING PAUSE,
        ;RESOLVE THE STATUS OF THE HARDWARE
        ;AND PREPARE DECISIONS FOR ENABLE/DISABLE.
.320:       .PAUSE
        .GOTO 300

.400:       .IFT REPCAL    .GOTO 800
        .IFT REPRED    .GOTO 900
        RUN LOG
```

```
.500:     RUN SYSCHK
     .IFF DIALOG   .GOTO 510
     ;IF ANY ENTRIES WERE BAD,
     ;ANSWER THE FOLLOWING WITH N.
.510:     ;ASK GOOD  ALL ENTRIES GOOD
     .IFT GOOD   .GOTO 600
     RUN ERASE
     .IFF DIALOG   .GOTO 520
     ;DURING THE FOLLOWING PAUSE,
     ;MAKE USE OF LOG, PRB AND ATN
     ;TO REMOVE THE BAD ENTRIES.
     ;UPON RESUME, ENTRIES WILL BE RECHECKED.
.520:     .PAUSE
     .GOTO 500

.600:     RUN ERASE
     .IFF DIALOG   .GOTO 610
     ;IF USE OF THE TV MONITORS
     ;FOR KNOB SETTING IS DESIRED,
     ;ANSWER THE FOLLOWING WITH Y.
.610:     .ASK TV  TV MODE
     .IFF TV   .GOTO 700
     RUN KNOB
     .IFT DIALOG; 7912'S NOW IN TV MODE
     ;SWITCH TO LOWER INTENSITY
     ;THEN USE INTERNAL TRIGGER

.700:     ;SET KNOBS
     .IFT TV; RESET TRIGGER AND INTENSITY
     .IFF DIALOG   .GOTO 710
     ;USE THE FOLLOWING PAUSE.
     ;RESUME WILL INITIATE BASELINE SHOT.
.710:     .PAUSE
     RUN BASE
     .SETF REPCAL
     .SETF REPRED
     .IFF DIALOG   .GOTO 720
     ;IF UNDESIRABLE ERRORS HAVE OCCURRED,
     ;ANSWER THE FOLLOWING WITH N.
     ;A Y WILL BRING A CAL SHOT IMMEDIATELY
.720:     .ASK GOOD SATISFACTORY RESULTS
     .IFF GOOD   .GOTO 300

.800:     RUN CAL
     RUN CHKCAL
     RUN ERASE
     .IFF DIALOG   .GOTO 810
     ;IF THE CAL DATA ARE NOT ACCEPTABLE
```

```
        ;OR UNWANTED ERRORS HAVE OCCURRED,
        ;ANSWER THE FOLLOWING WITH N.
   .800:     .ASK GOOD SATISFACTORY RESULTS
        .IFT GOOD   .GOTO 900
        .IFF DIALOG   .GOTO 820
        ;IF CHANGES TO SYSCON (OTHER THAN FLAGS)
        ;NEED NOT BE MADE AND IF A BASELINE
        ;SHOT NEED NOT BE REPEATED,
        ;ANSWER THE FOLLOWING WITH Y.
   .820:     .ASK REPCAL REDO CAL ONLY
        .SETF REPRED
        .GOTO 300

   .900:     RUN ERASE
        RUN SHOTNO
        RUN ERASE
        RUN PREDAT
       ..IFF DIALOG   .GOTO 910
        :7912's NOW READY FOR DATA RUN
        ;IF ANY UNWANTED ERRORS HAVE OCCURRED,
        ;ANSWER THE FOLLOWING WITH N.
   .910      .ASK GOOD SATISFACTORY RESULTS
        .IFT GOOD   .GOTO 1000
        .IFF DIALOG   .GOTO 920
        ;IF CHANGES TO SYSCON (OTHER THAN FLAGS)
        ;NEED NOT BE MADE AND IF BASELINE AND
        ;CAL NEED NOT BE REPEATED,
        ANSWER THE FOLLOWING WITH Y.
   .920:     .ASK REPRED REDO PREDAT ONLY
        .SETF REPCAL
        .GOTO 300

  .1000:     RUN ERASE
        .IFF DIALOG   .GOTO 1010
        ;A SHORT TIME AFTER ANSWERING THE
        ;FOLLOWING QUESTION WITH Y, THE SYSTEM
        ;WILL BE AWAITING A TRIGGER PULSE.
        ;ANSWER WITH N ONLY IF YOU WISH
        ;TO BACKTRACK TO THE PREVIOUS QUESTION
        ;AND BRANCH FURTHER BACK FROM THERE.
        ;IF THE SIMULATOR ABORTS,
        ;MANUALLY TRIGGER THE SYSTEM
        ;AND ANSWER THE SUBSEQUENT "ABORT?"
        ;WITH Y TO LOOP BACK TO RECOVER
  .1010:     .ASK TRIG NEAR TRIGGER TIME
        .IFF TRIG   .GOTO 910
        RUN DATA
        .IFT DIALOG; DATA SHOT TAKEN
```

```
.ASK ABORT ABORT
.IFT ABORT   .GOTO 900

RUN SCALE
RUN RAWCPY
RUN MARK
RUN ERASE
RUN TABIN
RUN SCACPY
RUN TABLES

RUN ERASE
;ONCE USER COMMENTS HAVE BEEN FILED
;(SEE XMTR LOG FOR NEXT SHOT),
;RUN THE TASK USRCOM.
;THE SHOT FILE WILL THEN BE COMPLETE
;AND SHOULD BE TRANSFERRED
;TO THE DAILY DATA TAPE WITH FLX.
;AS AN AID, RUNNING THE TASK PRTNAM
;WILL GIVE THE ACTUAL NAME
;OF THE PRESENT SHOT FILE.
```

APPENDIX D.-SYMDEF MACRO ENTRIES

SYMDEF is a macro routine that is called by virtually every task in the SKYNET Applications Software Package (SASP) code. Its function is to define SASP parameters in a single macro that is callable by every task. Note, the assigned values are given in octal.

Entry	Assigned value	Definition
ADRCB1	164000	UNIBUS address, Tektronix (TEK) R7912 digitizer controller card No. 1
ADRCB2	165000	UNIBUS address, digitizer controller card No. 2
ADRCB3	166000	UNIBUS address, digitizer controller card No. 3
ADRCB4	167000	UNIBUS address, digitizer controller card No. 4
ARMBIT	000020	Digitizer status bit for armed sweep
ATNDLY	000010	Offset for device delay in ATNCAL PSECT (program section)
ATNERR	000004	Bit for transmitter attenuator setting verification error
ATNGN	000004	Offset for device gain in ATNCAL PSECT
ATNID	000000	Offset for device identification (ID) in ATNCAL PSECT
ATNMDL	000014	Offset for device model in ATNCAL PSECT
ATNSER	000024	Offset for device manufacturer's serial number in ATNCAL PSECT
BADBIT	010000	Bit to indicate bad (incorrect) digitizer data word; set by software
BLMERR	001000	Bit for digitizer bloom error
BLMFAC	000004	Bloom multiplication factor for average to center of trace (ATC) routines
BLMMAX	000017	Maximum allowed bloom

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Entry	Assigned value	Definition
BLMMIN	000002	Minimum allowed bloom
BZYBIT	020000	Digitizer status bit for busy condition
BZYERR	000020	Bit for digitizer busy error
CALERR	000010	Channel error bit for bad (below-standard) calibration trace
CHNATN	000036	Offset for transmitter attenuator setting in channel entry in SYSCON (common area image of SYSCON.DAT file)
CHNAT1	000010	Offset for the attenuator ID in channel entry in SYSCON
CHNAT2	000030	Offset for device ID in channel entry is SYSCON
CHNBIS	000020	Offset for x-ray detector (XRD) bias in channel entry in SYSCON
CHNDGS	000052	Offset for list of digitizers associated with channel in channel's entry in SYSCON
CHNDLG	000060	Offset for the data link gain in channel entry in SYSCON
CHNDLY	000070	Offset for overall channel delay in channel entry in SYSCON
CHNFLG	000000	Offset for channel error flag in channel entry in SYSCON
CHNNDG	000050	Offset for number of digitizers associated with channel entry in SYSCON
CHNPRA	000044	Offset for postreceiver gain value in channel entry in SYSCON
CHNPRB	000014	Offset for probe/sensor ID in channel entry in SYSCON

Entry	Assigned value	Definition
CHNPRD	000040	Offset for postreceiver cable delay in channel entry in SYSCON
CHNPXD	000024	Offset for pretransmitter cable delay in channel entry in SYSCON
CHNSFR	000064	Offset for scale factor in channel entry in SYSCON
CHNTPN	000002	Offset for test point name in channel entry in SYSCON
CHNXMT	000034	Offset for transmitter address (or number) in channel entry in SYSCON
CH1BIT	000100	Digitizer status bit for channel No. 1 selected (for dual-channel plug-in unit in digitizer)
CLKBGN	000031	Command to start programmable clock for calorimeter data-taking mode
CLRBIT	000216	Digitizer status bits for complement of initialized (cleared) condition
CMDALL	002006	Digitizer command to enable data taking on both channels at dual vertical plug-in
CMDARM	002040	Digitizer command to arm single sweep
CMDCH1	002013	Digitizer command to select channel No. 1 of dual input to digitizer
CMDCH2	002003	Digitizer command to select channel No. 2 of dual input to digitizer
CMDCLR	004000	Digitizer command to initialize registers
CMDDGT	002015	Digitizer command to switch to digital mode
CMDDTA	002100	Digitizer command to start sending data
CMDERR	000040	Bit for digitizer command execution error
CMDGRT	002014	Digitizer command to enable graticule

Entry	Assigned value	Definition
CMDKRO	002002	Digitizer command to enable sending knob readout information immediately following data
CMDLCK	002017	Digitizer command to lock memory (write-protect)
CMDNGT	002004	Digitizer command to disable graticule
CMDNKO	002012	Digitizer command to inhibit sending of knob readout information
CMDREM	002016	Digitizer command to enable channel selection (dual input only)
CMDSTR	002020	Digitizer command to request status
CMDTV	002005	Digitizer command to switch to television (TV) mode
CMDUNL	002007	Digitizer command to unlock memory (remove write-protect)
CNTBZY	000012	Number of seconds for time-out on busy status for digitizer
CNTCMD	000017	Number of seconds for time-out on command for digitizer
CNTXMT	000074	Number of seconds for transmitter warm-up
CRGCLK	172544	UNIBUS address of count register of programmable clock
CSBCLK	172542	UNIBUS address of count set buffer of programmable clock
CSRCLK	172540	UNIBUS address of command and status register of programmable clock
DGTBIT	000200	Digitizer status bit for digital mode
DIGADR	000000	Offset for digitizer UNIBUS address in digitizer's entry in SYSCON
DIGBAS	000014	Offset for requested baseline trace position in digitizer entry in SYSCON

Entry	Assigned value	Definition
DIGBLM	000012	Offset for bloom in digitizer's entry in SYSCON
DIGCHN	000002	Offset for associated channel number in digitizer's entry in SYSCON
DIGFLG	000004	Offset for digitizer error flag in digitizer's entry in SYSCON
DIGHRZ	000006	Offset for requested horizontal sweep rate setting in digitizer's entry in SYSCON
DIGVRT	000010	Offset for requested vertical sensitivity setting in digitizer's entry in SYSCON
DISERR	000002	Bit for digitizer or channel disabled error
DTAMSK	177000	Mask for extraneous bits in digitizer data word
GRTBIT	000010	Digitizer status bit for graticule enabled
HDRASC	000014	Offset for American Standard Code for Information Interchange shot number in SYSCON header
HDRCLE	000144	Offset for calorimeter error flag in SYSCON header
HDRCL1	000130	Offset for channel A calorimeter result in SYSCON header
HDRCL2	000134	Offset for channel B calorimeter result in SYSCON header
HDRCOM	000070	Offset for simulator comment in SYSCON header
HDRCON	000046	Offset for pulser configuration code in SYSCON header
HDRDAT	000000	Offset for trigger date in SYSCON header
HDRIDP	000064	Offset for current diode peak value in SYSCON header
HDRLEV	000050	Offset for pulser output level in SYSCON header
HDRNBK	000126	Offset for number of blocks in MAIN.DAT or SHOT.DAT file in SYSCON header

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Entry	Assigned value	Definition
HDRNCB	000024	Offset for number of digitizer controller boards in system in SYSCON header
HDRNCH	000026	Offset for number of channels in system in SYSCON header
HDRNDG	000022	Offset for number of digitizers in system in SYSCON header
HDRNS1	000140	Offset for number of samples taken on calorimeter channel A in SYSCON header
HDRNS2	000142	Offset for number of samples taken on calorimeter channel B in SYSCON header
HDRSCV	000050	Offset for simulator charging voltage in SYSCON header
HDRSHN	000020	Offset for integer shot number in SYSCON header
HDRSIM	000044	Offset for simulator (or pulser) code in SYSCON header
HDRTIM	000006	Offset for trigger time in SYSCON header
HDRVAC	000054	Offset for tank vacuum in SYSCON header
HDRVDP	000060	Offset for voltage diode peak value in SYSCON header
HDRWIR	000046	Offset for wire type code in SYSCON header
HZMSK	001000	Bit set to indicate horizontal word in raw digitizer data
INTBIT	000100	Enable bit for digitizer interrupts
KROERR	000400	Bit for digitizer knob readout error
KROMSK	177600	Mask for extraneous bits in digitizer knob readout word
LKDBIT	000004	Digitizer status bit for locked memory (write-protect)

Entry	Assigned value	Definition
MISMAX	000012	Maximum number of mistakes in digitizer read verification allowed before another reading is requested
NEGMSK	100000	Bit set to indicate knob readout word in digitizer data
NOBERR	020000	Bit set for no digitizer baseline trace error
NOCERR	040000	Bit set for no digitizer calibration trace error
NODERR	100000	Bit set for no digitizer data trace error
NPTMIN	000144	Minimum number of points allowed for correct bloom calculation
NRDBLK	000010	Number of disk blocks required for raw digitizer data trace storage
NSCBLK	000005	Number of disk blocks required for SYSCON
OFFERR	000001	Bit set for digitizer or transmitter off-line error
OVFERR	000004	Bit set for digitizer data overflow error
PRBBLN	000026	Offset for balun number in PRBCAL PSECT
PRBCON	000054	Offset for connector in PRBCAL PSECT
PRBDLY	000010	Offset for probe delay in PRBCAL PSECT
PRBFLG	000024	Offset for integration flag in PRBCAL PSECT
PRBID	000000	Offset for probe sensor ID in PRBCAL PSECT
PRBMDL	000034	Offset for model in PRBCAL PSECT
PRBMT	000030	Offset for measurement type in PRBCAL PSECT
PRBPAR	000064	Offset for parameter in PRBCAL PSECT
PRBSER	000044	Offset for serial number in PRBCAL PSECT
PRBTF	000004	Offset for transfer function in PRBCAL PSECT

Entry	Assigned value	Definition
PRBUNT	000014	Offset for units in PRBCAL PSECT
PRICLK	000300	Priority for clock interrupts
PRIDIG	000300	Priority for digitizer interrupts
PRITRG	000300	Priority for trigger interrupts
RAWMAX	003720	Maximum number of raw digitizer data words allowed
RAWMIN	001750	Minimum number of raw digitizer data words allowed
REMBIT	000002	Digitizer status bit for enabled channel selection
SGLBIT	000040	Digitizer status bit for single sweep mode
SHFERR	002000	Bit set for digitizer baseline trace positioning error
SHFMAX	000015	Maximum allowed number of points between digitizer baseline trace position and requested position
SIZCHN	000100	Size in bytes of channel entry in SYSCON
SIZDIG	000020	Size in bytes of digitizer entry in SYSCON
SIZHDR	000200	Size in bytes of SYSCON header
TANMAX	000012	Maximum allowed absolute value of slope between two points of ATC of digitizer trace
TRGERR	000100	Bit set for digitizer failure-to-trigger error
TRYMAX	000012	Maximum allowed number of attempts at verified read of digitizer
UNFERR	000010	Bit set for digitizer data underflow error
UNTMSK	177707	Mask for digitizer unit number in controller status register (upon interrupt) of digitizer controller card
VBNBAS	000030	Virtual block number for beginning of baseline trace storage in MAIN.DAT or SHOT.DAT file

Entry	Assigned value	Definition
VBNCAL	000032	Virtual block number for beginning of calibration trace storage in MAIN.DAT or SHOT.DAT file
VBNPAR	000040	Virtual block number for beginning of parameter storage in MAIN.DAT or SHOT.DAT file
VBNRAW	000034	Virtual block number for beginning of raw data trace storage in MAIN.DAT or SHOT.DAT file
VBNSCA	000036	Virtual block number for beginning of scaled data trace storage in MAIN.DAT or shot file
VBNUSR	000042	Virtual block number for beginning of user comment storage in MAIN.DAT or SHOT.DAT file
VECCB1	000374	Vector address for digitizer controller card No. 1
VECCB2	000370	Vector address for digitizer controller card No. 2
VECCB3	000364	Vector address for digitizer controller card No. 3
VECCB4	000360	Vector address for digitizer controller card No. 4
VECCLK	000104	Vector address for programmable clock
VECTRG	000334	Vector address for trigger
VFYERR	000200	Bit set for digitizer read verification error
XCHCAL	000014	Offset for calibration generator output level in XCHCAL PSECT
XCHDLY	000010	Offset for delay in XCHCAL PSECT
XCHFBR	000002	Offset for fiber number in XCHCAL PSECT
XCHREC	000004	Offset for receiver number in XCHCAL PSECT
XCHXMT	000000	Offset for transmitter address number in XCHCAL PSECT
XHDBLN	000030	Offset for balun insertion loss table in XCHHDR PSECT
XHDDR1	000010	Offset for first part of trigger path delay (Δt_{trig_1}) in XCHHDR PSECT

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Entry	Assigned value	Definition
XHDDR2	000014	Offset for second part of trigger path delay (Δt_{trig_2}) in XCHHDR PSECT
XHDDTF	000020	Offset for fiducial path delay (Δt_{fidu}) in XCHHDR PSECT
XHDDTV	000024	Offset for vertical plug-in delay (Δt_{vert}) in XCHHDR PSECT
XHDDT1	000004	Offset for source to XRD transit time in XCHHDR PSECT
XHDNCH	000000	Offset for number of channels entered in XCHCAL.DAT file in XCHHDR PSECT

APPENDIX E.--LIBRARIES: MACRO AND OBJECT

To facilitate program development, maintenance and understanding, similar subroutines and macros are grouped together into object or macro libraries resident on the system disk.

Name	Contents	Purpose
ERROR (Object)	CHNERR DCDBIT DIGERR DISCHN ERRNUM IASCII LSTERR .RSTR .SAVE	List and flag digitizer and channel errors
HANDLR (Object)	BUSY CHKTRG CLRCBD CMDDIG FLGPTS INTABL INTDIG RDIG SETVEC	Digitizer handling routines; many reference error reporting routines in library ERROR
INPUT (Object)	ANSWER ASDCD FIELD FLDCD FLOTE FXDCD IFICKS INPUT	Terminal input routines
NORMAL (Object)	BASATC CALATC DATATC ELIMPT EXTRAP INTRP ISBASE QKELIM QKLNTP SUBASE	Normalization routines

APPENDIX E

Name	Contents	Purpose
SKYNET (Macro)	RDSECT SCSECT SYMDEF	General, system-wide macros

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